**NATIONAL EXAMINATIONS – May 2018**
**16-CIV-B3, GEOTECHNICAL DESIGN**

**3 HOURS DURATION**

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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:**
Suggest any two of the equipment shown in **Figure 1** that you would recommend for the reliable determination of the settlement behavior for sands. Give reasons.

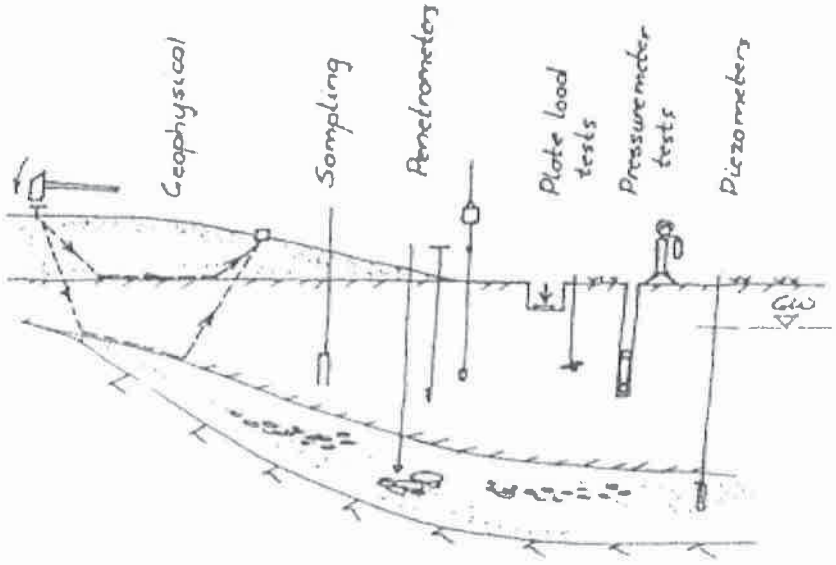


**Figure 1**

**(Value: 7 marks)**

**Question 2:**
Would you suggest recommending a higher or lower FS for the short-term stability of a slope excavated in a saturated clay? Give reasons. **(Value:7 marks)**

**Question 3:**
With a practical example explain when you would design a foundation using undrained shear strength parameters? How do you determine the undrained shear strength both in the laboratory and in the field? What are strengths and limitations of these testing techniques? **(Value: 7 marks)**

**Question 4:**
Provide reasons with theoretical or mathematical explanation why a steep excavation in a clayey soil can be stable for a short period of time without any lateral support.

**(Value: 7 marks)**

**Question 5:**
When do you prefer to use a mat foundation in comparison to either individual or combined footings or pile foundations? **(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 2**, using a factor of safety of 2.5. Make reasonable assumptions providing justifications.

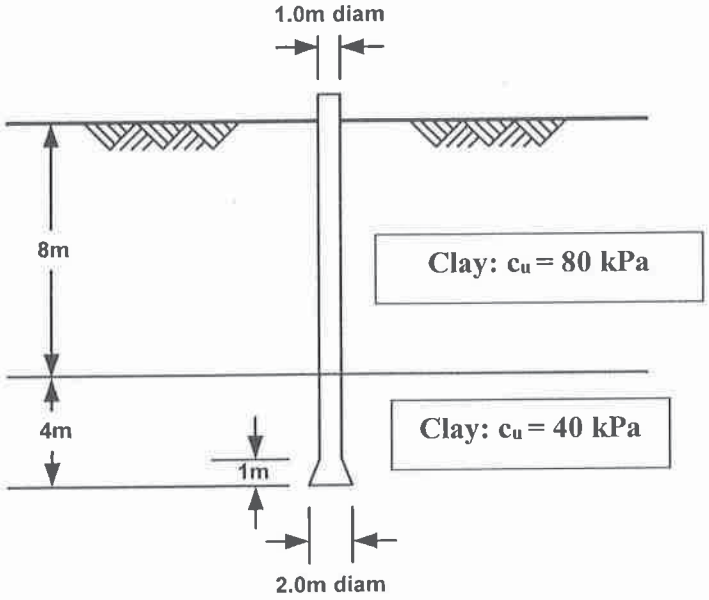


**Figure 2**

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

The Table given below provides the details of the field standard penetration number, $N_F$ with depth in a sand deposit.

| Depth (m) | Field SPT, $N_F$ |
|---|---|
| 2 | 10 |
| 4 | 12 |
| 6 | 14 |
| 8 | 16 |
| 10 | 17 |
| 12 | 18 |

The groundwater table is located at a depth of 3m. The dry unit weight of sand from natural ground level to a depth of 3m is 17.5 kN/m$^3$, and the saturated unit weight of sand for the depths from 3m to 12 m is 20.1 kN/m$^3$.

(i) Determine the corrected standard penetration number, $(N_{60})_{ave}$ that you would recommend in the design. Use Skempton's correction factor.
(ii) Comment on the SPT results you have obtained. What information can you derive from these test results both with respect to shear strength behavior and for the design of shallow foundations?
(iii) What is the need for correcting the field standard penetration values from an engineering practice point of view?
(iv) Would you recommend designing a foundation for this sand based on Meyerhof's general bearing equation or using the corrected SPT data? Give reasons.

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

Details of a cantilever retaining wall are shown in **Figure 3**. The unit weight of the material is 23.5 kN/m$^3$. Determine the factor of safety (FS) against (a) **overturning** and (b) **sliding**. (The friction between the base and the foundation soil, $\delta'$ is equal to $0.75\phi'$). Comment on the FS values determined. What measures would you suggest to improve the Factors of Safety, if they don't meet the design criteria? **(Note: the water content above GWT is 10% and specific gravity of the backfill material is 2.7)**

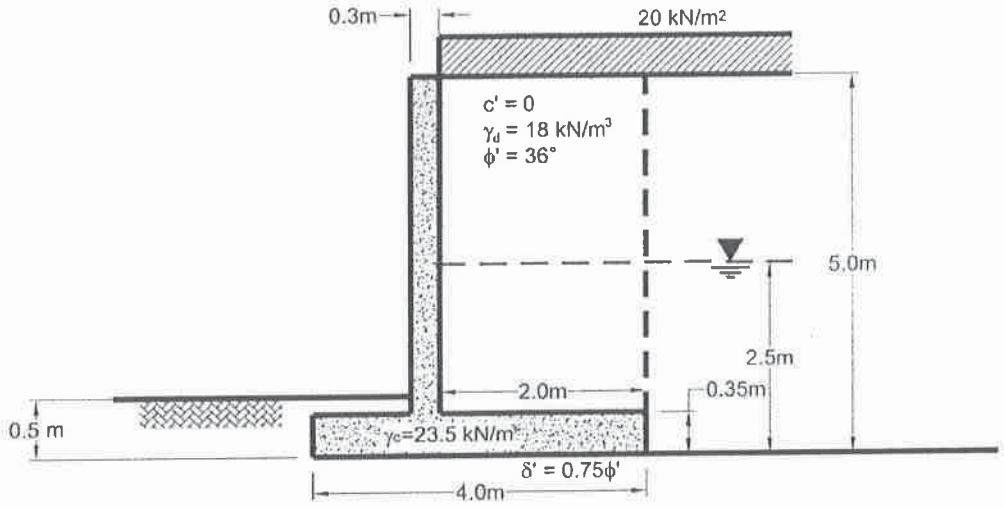


**Figure 3**

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

The elasticity with depth in an **erratic** sandy deposit varies considerably. Representative data of Elasticity versus depth is shown below:

| Depth (m) | Data Set 1 Elasticity ($kN/m^2$) | Data Set 2 Elasticity ($kN/m^2$) | Data Set 3 Elasticity ($kN/m^2$) |
|---|---|---|---|
| 0 to 2 m | 5000 | 3000 | 8000 |
| 2 to 8 m | 10000 | 6000 | 12000 |
| 8 to 12 m | 15000 | 12000 | 20000 |
| 12 to 16m | 12000 | 8000 | 15000 |

It is proposed to construct a continuous footing with L/B > 15, on this soil that has a foundation depth equal to 2m and width equal to 2.5m. Assume $\gamma = 20$ $kN/m^3$ and creep time of 12 years for the correction factor $C_2$. Calculate the expected **maximum elastic settlement** of the foundation using the given data. Use the Schmertman strain influence factor method for calculations. The stress at the level of the foundation is equal to 150 kPa. **(Clue: You don't have to calculate the settlement for all three sets of test data; use engineering judgement and solve this problem)**