# NATIONAL EXAMINATIONS – December 2009
# 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.

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# SECTION A
# ANSWER ANY **FOUR** QUESTIONS

**Question 1:**

| | | | |
|---|---|---|---|
| 1 | Elastic settlements in sandy soils can be more reliably determined from consolidation tests (determining the compression index, $C_c$). | T | F |
| 2 | Two soils; Soil A an over consolidated clay and Soil B a normally consolidated clay were subjected to the same loading. The settlement in Soil B due to the applied loading will be higher in comparison to Soil A. | T | F |
| 3 | Samples required for the determination of the soil classification properties such as the Atterberg limits of a clayey soil have to be obtained from undisturbed specimens. | T | F |
| 4 | The allowable settlements in sands are always higher in comparison to clays. | T | F |
| 5 | Skempton's bearing capacity theory can be applied for estimating the bearing capacity of saturated clays under undrained loading conditions. | 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 twice the width of the foundation with greater weight given to values closer to the base of the foundation. | T | F |
| 7 | The effective cohesion, $c'$ value can never be a negative value irrespective of the soil being an over-consolidated or a normally consolidated clay. | T | F |

**(Value: 7 marks)**

**Question 2:**
Plate load tests (PLT) and cone penetration tests (CPT) are both used in the determination of the bearing capacity of soils. However, each of these techniques has their limitations. What are the limitations of each of these techniques for practical applications?

**(Value: 7 marks)**

**Question 3:**
When designing a pile, when do you prefer to use the $\alpha$ method in comparison to the $\beta$ and $\lambda$ methods? Discuss with two practical examples.

**(Value: 7 marks)**

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**Question 4:**
Suggest a suitable type of foundation that you would recommend for the following cases:

(i) for a TV tower that is 30 m in height in a soft clay

(ii) for an industrial structure (which would be subjected to both static and dynamic loading equipment) that has to be constructed on a relatively loose sand deposit extending 20 m depth.

State specific reason/s for your recommendation for both cases

**(Value: 7 marks)**

**Question 5:**
Several methods of ground improvement are possible using geosynthetics. Discuss two examples of how geosynthetics can be used for geotechnical engineering applications in practice.

**(Value: 7 marks)**

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

**Question 6:** **(Value: 24 marks)**
Calculate the theoretical value of the required depth of embedment, $D$, for the anchored sheet pile wall shown in the figure below. Also, draw the pressure distribution diagram and determine the anchor force per unit length. Use the free-earth support method. Add a symbol for the water level

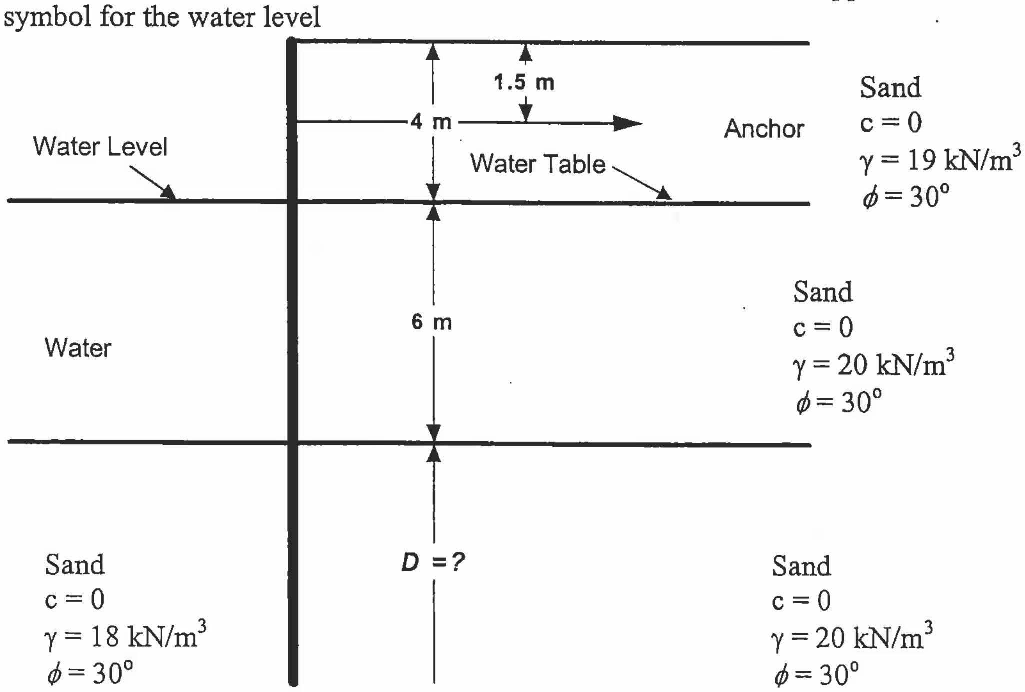

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**Figure 1**

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

A strip foundation on a layer of sand is shown in Figure 2 below, along with the variation of the modulus of elasticity of the soil, $E_s$. Assuming that $\gamma = 21$ kN/m$^3$ and assuming a creep time of 12 years for the correction factor $C_2$, calculate the elastic settlement of the foundation, using Schmertmann's strain Influence Factor.

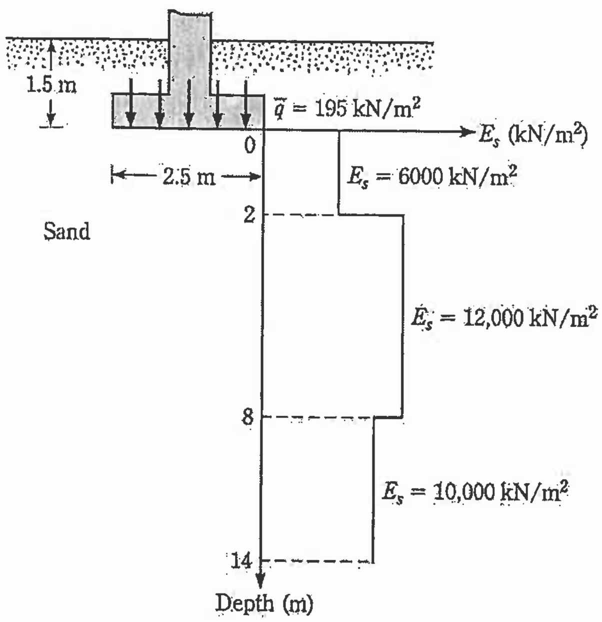


**Figure 2**

**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.

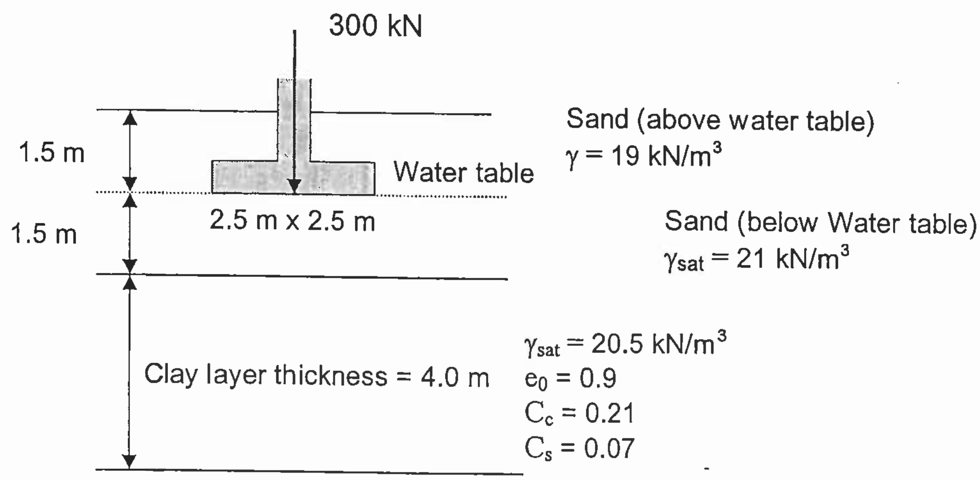

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**Figure 3**

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

A 0.3 m steel H-pile is driven 20 m into a clay soil where the following conditions exist: From the ground surface to a depth of 8 m, the clay is normally consolidated, with a unit weight equal to 16 kN/m$^3$ and undrained cohesion equal to 60kPa; below 8 m, the clay is slightly overconsolidated, with a unit weight equal to 18 kN/m$^3$ and undrained cohesion equal to 110 kPa. Determine the design axial capacity of this pile, using a factor of safety of 2. Compute the shaft capacity by assuming that the skin friction is developed on the surface of the rectangular outer perimeter (0.3 m by 0.3 m) of the pile cross-section.