00205

The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Civil Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX6444/CVX6530 Geotechnics**
Academic Year	: 2020/21
Date	: 2nd February 2022
Time	: 1400-1700hrs
Duration	: **3 hours**

General Instructions

1. Read all instructions carefully before answering the questions.
2. This question paper consists of **Seven (7)** questions in **Six (6)** pages.
3. Answer any **Five (5)** questions only. All questions carry equal marks.
4. Answer for each question should commence from a new page.
5. Relevant charts/ codes are provided.
6. This is a Closed Book Test (CBT).
7. Answers should be in clear hand writing.
8. Do not use Red colour pen.

Question 1.

A direct shear test was conducted on a sand sample until failure and the principal stresses (81.99 kN/m^2 and 27.33 kN/m^2) acting on a soil element on the failure plane are indicated in Figure Q1.

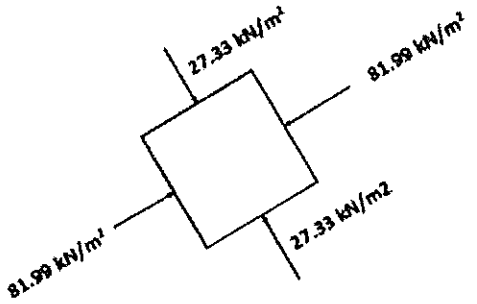

Figure Q1 – Principal stresses acting on a soil element on the failure plane

(a). Plot the Mohr circle at failure. (04 Marks)

(b). Identify the pole of the Mohr circle at failure. (02 Marks)

(c). Determine the internal angle of friction of tested sand. (04 Marks)

(d). Determine the shear stress and normal stress at failure. (04 Marks)

(e). Plot the Mohr circle corresponding to the stress condition of the sand sample before shearing started when only the normal stress is applied and identify the pole of this circle. (06 Marks)

Question 2.

An approximate flownet drawn for seepage under a dam is shown in Figure Q2.

(a). Determine the flow rate under the dam in m^3/day if the permeability of soil under the dam is 4.0 x 10^{-4} cm/s. (04 Marks)

(b). Determine the pore water pressure along the base of the dam at points a, b, c, d, e, f, and g. (07 Marks)

(c). Calculate the approximate uplift force acting on the dam. (06 Marks)

(d). Calculate the required weight of the dam to prevent uplift with a factor of safety of 1.2. (03 Marks)

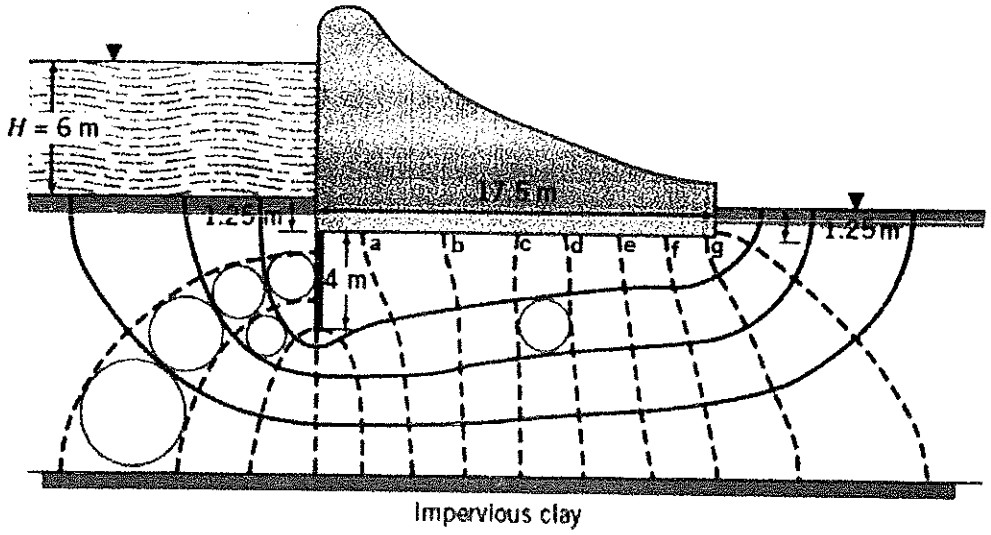

Figure Q2

Question 3.

An eccentric footing A, located at the boundary of a property as shown in Figure Q3, supports a column load of 1,335 kN. In order to improve the stability of this footing, it is connected to an internal concentric footing B, which carries a column load of 2,000 kN, using a strap beam as shown (column loads are un-factored service loads). It is intended to achieve uniform contact pressures under both the footings using this arrangement. Ignore the weights of footings and the strap beam in your calculations.

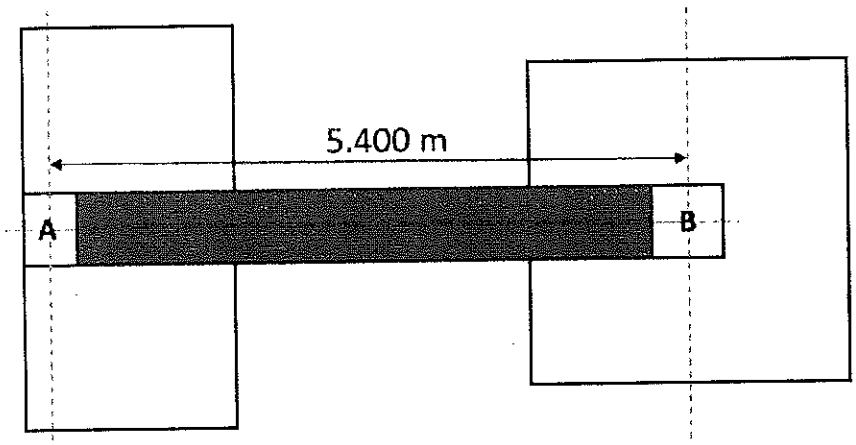

Figure Q3

Footing	Column Size (mm x mm)	Footing Size (mm x mm)
A	450 x 600	1800 x 3400
B	600 x 600	2700 x 2700

Centre to centre distance between columns is 5.400m.

(a). Determine the uniform contact pressures acting under the footings A and B in order to verify that the values do not exceed the 250 kN/m^2 allowable bearing pressure of the soil. (10 Marks)

(b). Determine the maximum bending moment under serviceability limit state developed in the strap beam. (10 Marks)

Question 4.

(a). Figure Q4 shows the existing soil profile under a proposed road embankment construction. It is required to assess the stability of organic clay under the application of the additional load due to the proposed construction and you are required to make decisions on the assessment.

i) If the embankment construction is to be completed in a very short duration discuss whether you should perform a short-term or a long-term stability analysis. Explain the reasons for your choice with neat sketches (Hint: consider the stress path soil element A is subject to due to proposed loading). (03 Marks)

ii) Discuss whether you should perform a total stress or an effective stress analysis. Justify your choice with reasons. (03 Marks)

iii) Explain the laboratory test procedure you would follow on samples collected from the location in order to achieve the above objectives. (04 Marks)

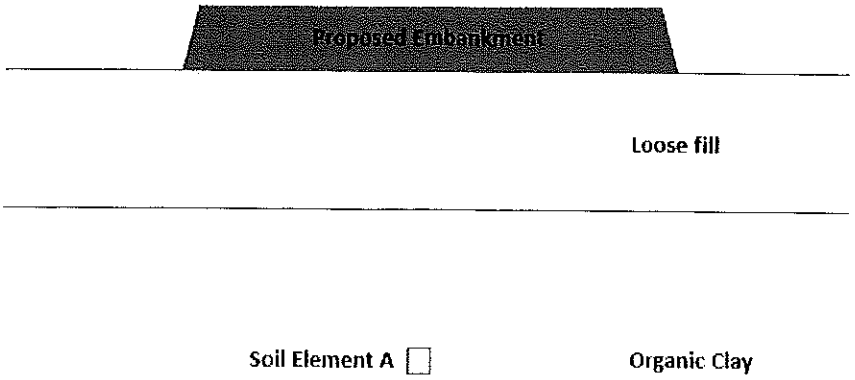

Figure Q4

(b). Discuss the mechanisms that cause landmass to accelerate its movement during extended wet weather periods. (06 Marks)

(c). Discuss the use of Standard Penetration Test results (SPT N value) in designing a shallow foundation. (04 Marks)

Question 5.

The cantilever retaining wall shown in Figure Q5 is backfilled with granular material having a unit weight of 19.0 kN/m^3 and an angle of friction of 30°. Groundwater table is below the base of the retaining wall. Weight of wall material is 24 kN/m^3. Ignore the passive resistance of soil in front of the wall in your calculations and use Rankine's theory to compute lateral earth pressures.

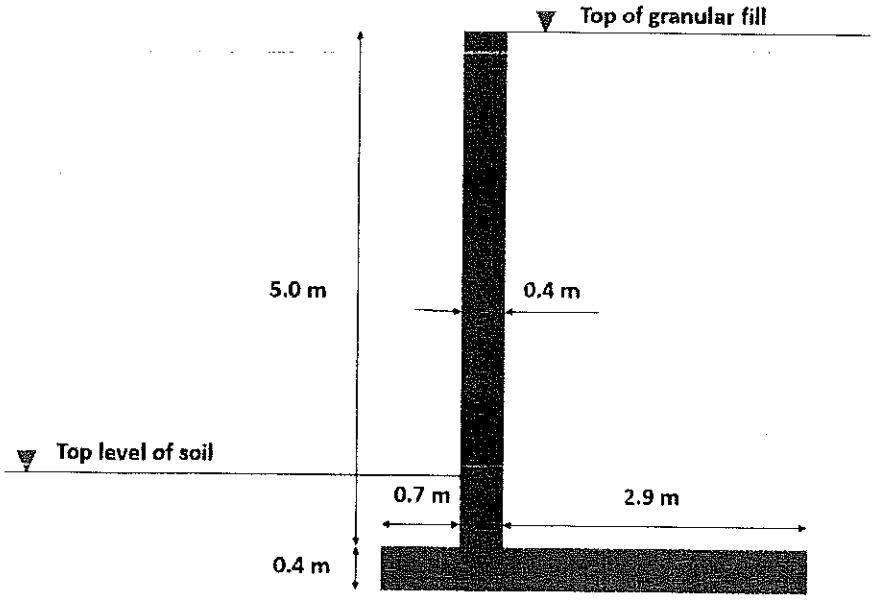

Figure Q5

(a). Determine the factor of safety against overturning. (06 Marks)

(b). Determine the factor of safety against sliding assuming the friction coefficient between wall base and the soil underneath = 0.40. (06 Marks)

(c). Assuming the allowable bearing pressure of soil underneath the base is 120 kN/m^2, check the safety against a bearing failure. (08 Marks)

Question 6.

(a). A foundation constructed as shown in Figure Q6 exerts a net increase in loading of 150 kN/m^2. Compute the consolidation settlement caused by the construction of the foundation. Assume a 2V: 1H load spread for the foundation load. Geotechnical properties of the two different types of clay, i.e. Clay 1 and Clay 2, are shown in Figure Q6 (σ'_c is pre-consolidation pressure). Ground water table is at the base of the footing. (16 Marks)

(b). Discuss how pre-fabricated vertical drains accelerate consolidation settlement when a pre-load is applied. (04 Marks)

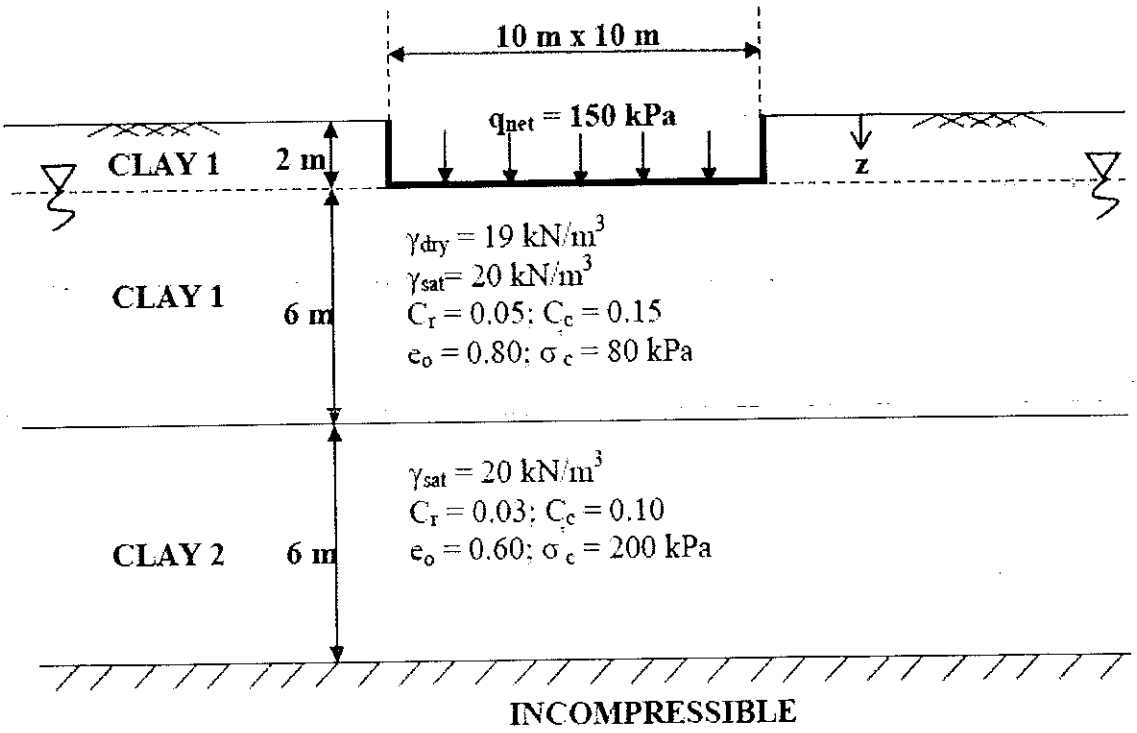

Figure Q6

Question 7.

(a). Explain the term "efficiency" in relation to pile groups. (03 Marks)

(b). Explain what you understand by "negative skin friction" of piles and describe two situations where piles are subjected to negative skin friction. (03 Marks)

(c). Explain how a maintained load test is conducted and the purpose of the test. (04 Marks)

(d). Figure Q7 shows a 1.20m diameter bored and cast in-situ pile constructed in a sandy soil. Geotechnical properties of the two different types of sand layers are given below. Water table is at the interface of the two sand layers.

Sand Layer 1: $\gamma = 17.0\ kN/m^3$, $\phi' = 24°$, $K_s = 1.0$, $\delta = 0.75\ \phi'$, $N_q = 20$

Sand Layer 2: $\gamma_{sat} = 18.0\ kN/m^3$, $\phi' = 30°$, $K_s = 2.0$, $\delta = 0.75\ \phi'$, $N_q = 39$

Determine the ultimate skin friction and ultimate end bearing of the pile. (10 Marks)

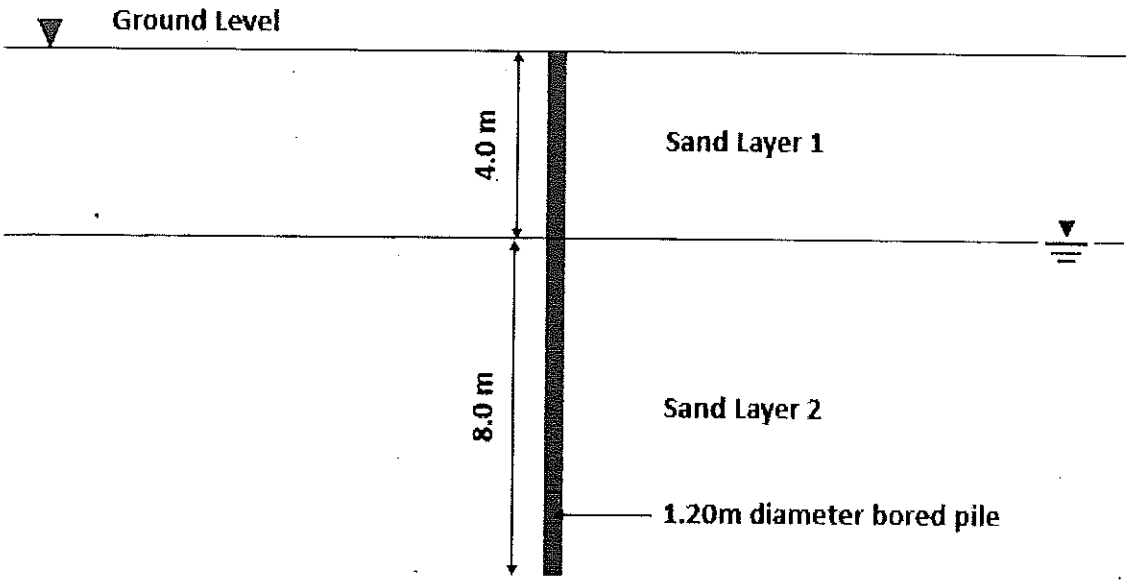

Figure Q7