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

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Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: CVX6530/CEX6230 Geotechnics**
Academic Year	: 2017/18
Date	: 21st January 2019
Time	: 1330-1630hrs
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 gravity retaining wall (Density of wall material = 22 kN/m^3) shown in the figure Q1 is required to retain 5.0 m of cohesionless soil. Soil properties are; bulk unit weight =18.0 kN/m^3, and friction angle of ϕ'=30°. The wall is embedded 1.0 m as shown and a drainage system is provided. The ground water table is below the base of the wall. Ignore any passive resistance from the soil in front of the wall and use Rankine's theory to evaluate lateral earth pressures. Take the coefficient of friction between base of wall and soil = tan ϕ'.

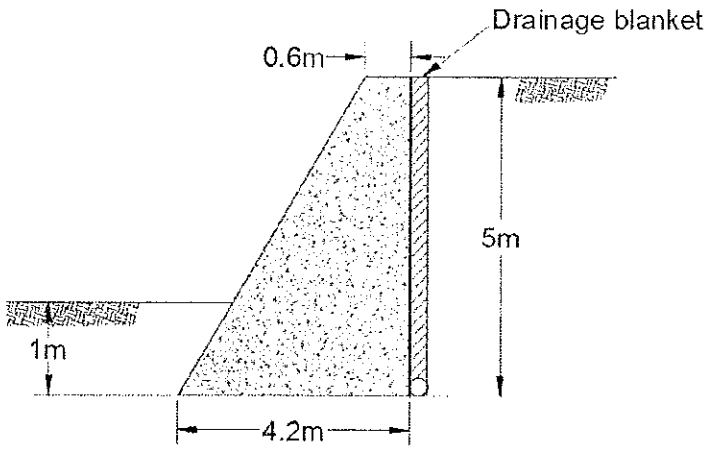


Figure Q1

(a). State the purpose of the drainage blanket. (02 Marks)
(b). Determine the factor of safety against sliding. (06 Marks)
(c). Determine the factor of safety against overturning. (06 Marks)
(d). Determine the maximum and minimum bearing stresses exerted by the retaining wall.(06 Marks)

Question 2.

Design the foundation shown in Figure Q2 to support the following two columns with uniform contact pressure: Dead load (DL) and live load (LL) acting on each column are:

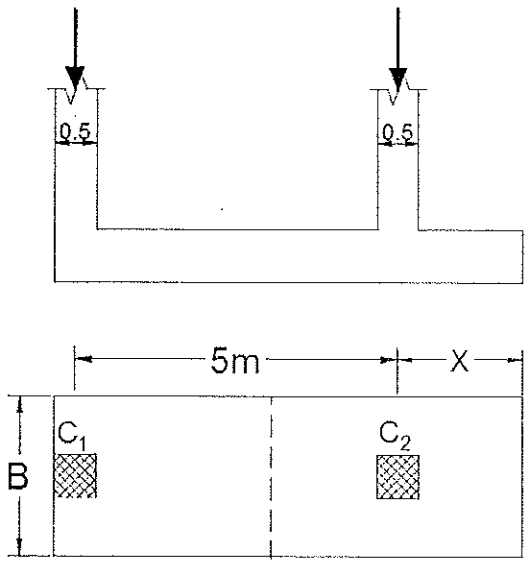


Figure Q2

Column C1: DL = 500 kN, LL = 250 kN, cross section : 50cm × 50cm.
Column C2: DL = 700 kN, LL = 350 kN, cross section : 50cm × 50cm.
Neglect effects due to weight of the foundation and backfill.

(a). What are the circumstances necessitating a combined footing? Illustrate with a neat sketch. (02 Marks)

(b). State the requirement which needs to be satisfied to achieve a uniform pressure distribution underneath the base of a combined footing. (02 Marks)

(c). Find the distance X so that the contact pressure is uniform. (05 Marks)

(d). If net allowable bearing pressure = 200 kN/m^2, Calculate B. (05 Marks)

(e). Draw diagrams to indicate the variation of shear force and bending moment along the footing. (06 Marks)

Question 3.

Consolidated undrained (CU) triaxial tests with pore pressure measurements are widely used to determine the shear strength parameters of soils in terms of effective stress.

(a). Draw the stress condition a soil sample is subjected to inside the triaxial cell during the initial condition when only all-round cell pressure (σ_c) is acting on the sample. (02 Marks)

(b). A vertical axial stress (σ_{axial}) is then applied in case of a loading test. Draw the stress condition the soil sample is subjected to now and determine the relationship between σ_1, σ_3 and σ_{axial}. (04 Marks)

(c). Explain why CU test with pore pressure measurements is widely used over consolidated drained (CD) test to determine effective stress strength parameters. (02 Marks)

(d). Results of three consolidated undrained triaxial (CU) tests on identical specimens of a particular soil are given in Table Q3. Determine c' and ϕ' of tested soil. (06 Marks)

Table Q3

Test No	Cell Pressure (kN/m^2)	Deviatoric Stress at failure (kN/m^2)	Pore pressure at failure (kN/m^2)
1	200	244	55
2	300	314	107
3	400	384	159

(e). A different specimen of the same soil is subjected to the same test at a cell pressure of 100 kN/m^2 and fails when the deviator stress is 174.1 kN/m^2. Determine the pore pressure in the specimen at failure. (06 Marks)

Question 4.

A well pumping test was carried out to determine the permeability of a confined aquifer. The aquifer was overlain by a clay layer of 4 m thickness, the depth of the aquifer was 20 m, and the initial piezometric level in the aquifer was 2m below ground level. After a period of pumping when steady-state conditions had been reached, the following observations were made.
pumped flowrate = 1.637 litres/second
well radius = 0.1 m
drawdown just outside well = 2 m
drawdown in piezometer at 100m distance from well = 0.2 m

(a). Derive from first principals the equation used to determine permeability. (06 Marks)
(b). Determine the permeability of the aquifer. (07 Marks)
(c). What would be the drawdown if the observation well was at 50m distance? (07 Marks)

Question 5.

Figure Q5 shows a flood control dam constructed along the bank of a river. The structure is founded on a clayey silt with a coefficient of permeability of 4.2 x 10^{-4} cm/s. Saturated unit weight of clayey silt is 19.0 kN/m^3.

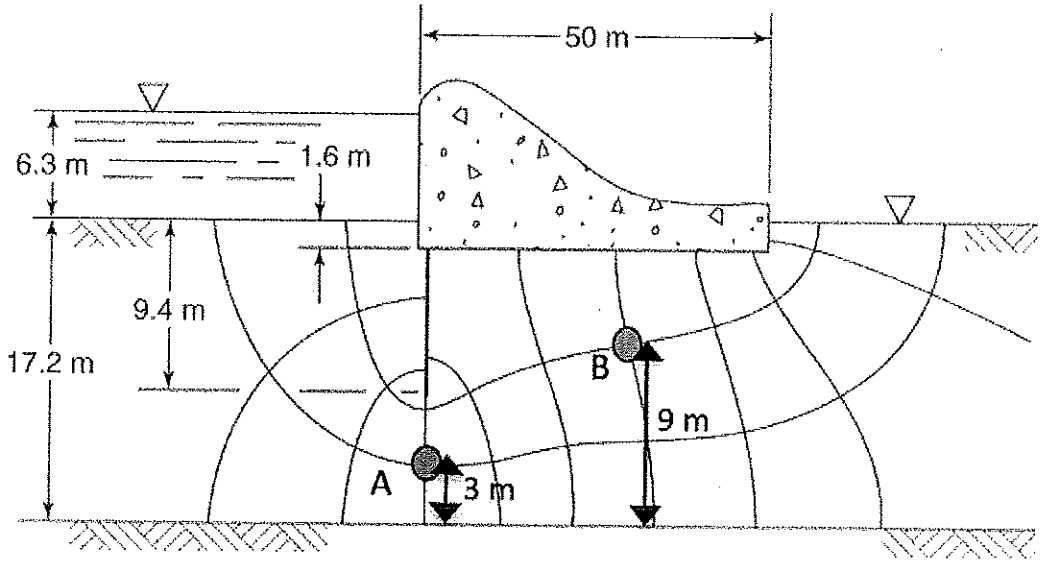


Figure Q5

(a). Explain the purpose of the cut off wall provided. (02 Marks)
(b). Compute the seepage under the dam in m^3/s per meter length of dam. (04 Marks)
(c). Evaluate the pressure head at points A and B. (04 Marks)
(d). Determine the approximate uplift force on the base of the dam in kN per meter length of dam. (05 Marks)
(e). Identify the location where hydraulic gradient is maximum and estimate the value. (05 Marks)

Question 6.

(a). Explain with neat sketches how pre-fabricated vertical drains can be used to reduce subsequent settlements when loads are applied to saturated compressible soils. (04 Marks)
(b). Figure Q6b shows a design chart frequently used by geotechnical engineers. Identify the three variables associated with the chart, the purpose of the chart and explain how to use it. (04 Marks)
(c). Figure Q6c shows piston spring analogy used to explain the primary consolidation process. Discuss how the principle of effective stress is explained using this analogy. (04 Marks)
(d). Indicate with a neat sketch to illustrate a situation where a soil element in the field can be subjected to a loading situation. For this soil element if in a saturated clayey soil layer, explain whether the short term or long term stability is critical. Discuss this for the two cases separately with neat sketches of stress paths followed if the soil is Normally Consolidated (NC) and Over Consolidated (OC). (08 Marks)

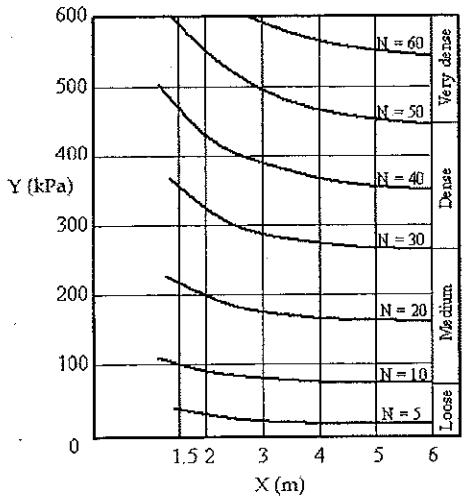


Figure Q6b

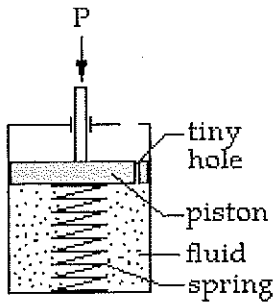


Figure Q6c

Question 7.

(a). Explain the concept of negative skin friction applicable to piles. (05 Marks)

(b). Differentiate between individual failure and block failure in a pile group. (05 Marks)

(c). A canal with side slopes of 60° as shown in Figure Q7c has a vertical height of 8 m. Soil properties are c = 25 kN/m2; ϕ = 20°; submerged unit weight = 9.99 kN/m^3. Assuming that the same factor of safety is allowed on both cohesion and friction, calculate Factor of Safety using Taylor's Stability Chart for the two conditions, when the canal is flowing full and suddenly emptied. (10 Marks)

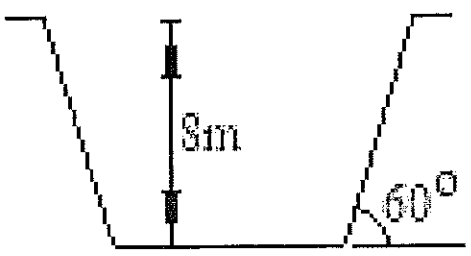
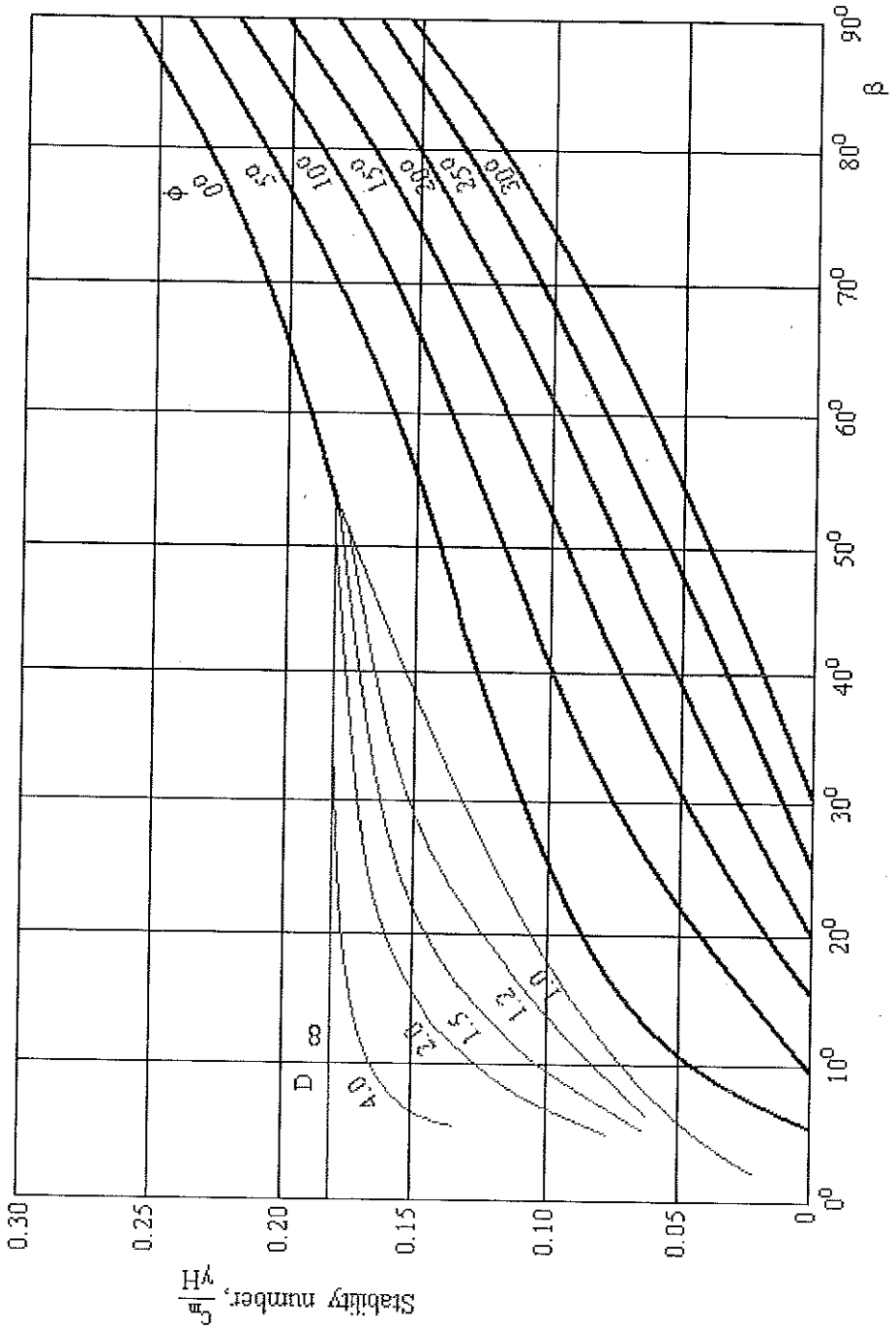


Figure Q7c



Taylor's Stability Chart