Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2, 2017					

ENG464 – Geotechnical Engineering	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

The examination has one (1) section with four (4) questions: answer all questions.

Please write your answers in the booklet provided.

Please ensure that your name and student number are clearly indicated on your answers and at the top of this examination paper.

Note that all questions are of equal value (25 marks each).

This examination accounts for a total of 50 % of the marks available for this unit.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a CLOSED BOOK examination.

Any non-programmable calculator is permitted.

No handwritten notes are permitted.

No dictionaries are permitted.

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted.	1 x 20 page book 1 x scrap paper 1 × graph paper

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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Question 1. (25 marks)

A pile group of 8 x 8 cylindrical bored, cast *in situ*, piles at 2.4 m centres, each with a diameter of 600 mm, and extending from 3 m depth to 20 m depth, is constructed in a stratum of stiff clay, with a thickness of approximately 40 m, overlying bedrock. The undrained shear strength of the clay at a depth of 20 m is 80 kPa and an average value over the pile length is 40 kPa. The undrained elastic modulus E_u of the clay should be estimated for the purposes of this analysis in the absence of laboratory test data (candidates must justify their estimate of E_u).

(a) If the pile group supports a fully factored load of 40 MN, determine the global factor of safety.

(17 marks)

(b) Estimate the immediate pile head settlement S_i using your chosen value of E_u. Coefficients μ_0 and μ_1 for vertical displacement S_i are given in Figure Q.1.

(8 marks)

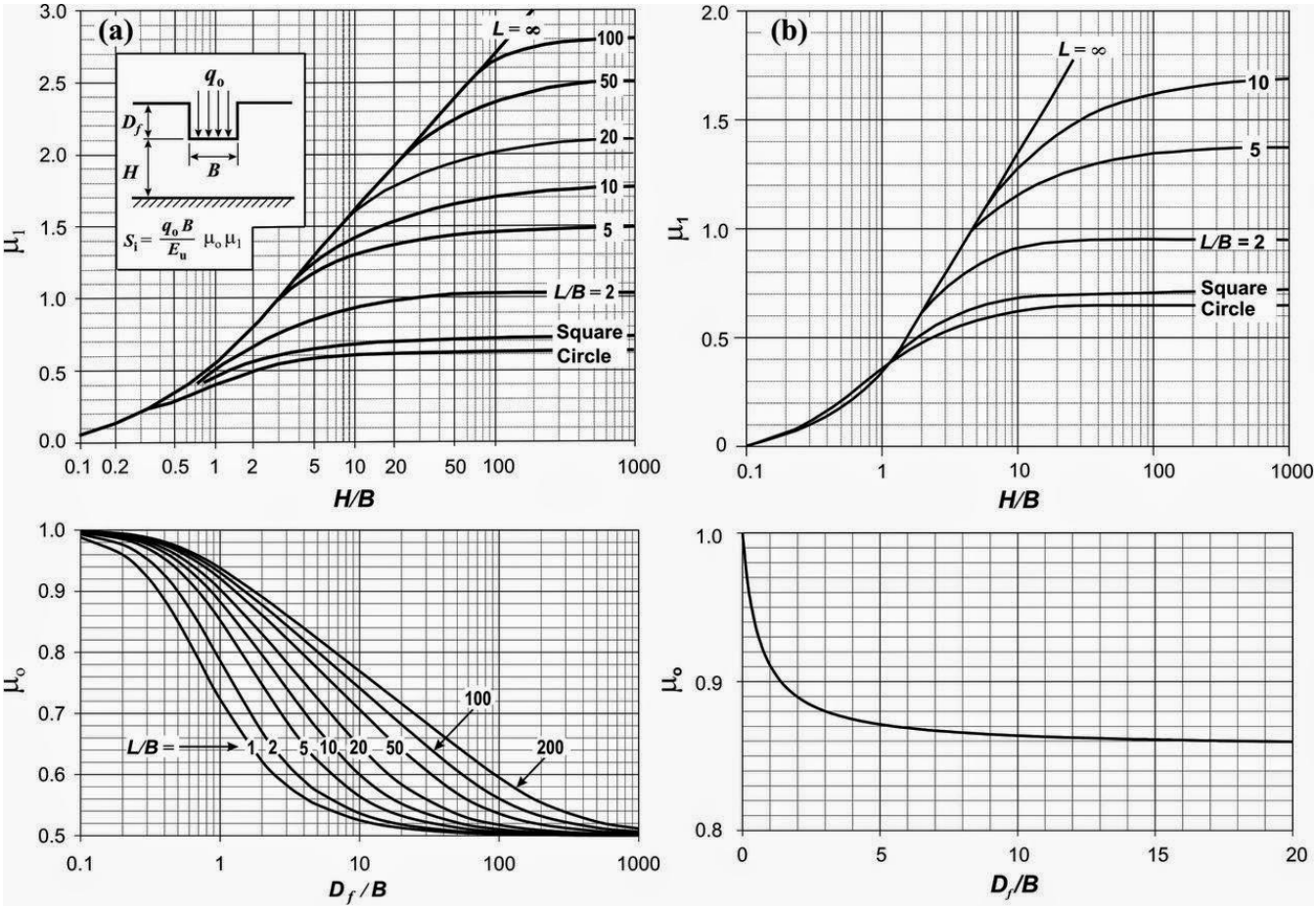

Figure Q.1 Coefficients for vertical displacement

Question 2. (25 marks)

A clay layer, with a thickness of 6 m and a coefficient of consolidation c_v of 1.0 m^2/year, is drained on both its upper and lower surfaces. Piezometric measurements indicate that the layer is subjected to a linear pore water pressure distribution ranging from 60 kPa at its upper surface to zero at its base.

(a) Using a finite difference approximation to the one-dimensional consolidation equation, plot the pore water pressure distribution after three years and estimate the degree of consolidation within the layer. Taylor's approximate solution to the governing differential equation is given by:

$$u_{i,j+1} = u_{i,j} + \frac{c_v \Delta t}{(\Delta z)^2}\left(u_{i-1,j} + u_{i+1,j} - 2u_{i,j}\right)$$

where operator β is given by:

$$\beta = \frac{c_v \Delta t}{(\Delta z)^2}$$

The dimensionless time factor T_v is equal to $\frac{c_v t}{h_d^2}$ for drainage path length h_d at time t.

(19 marks)

(b) A granular fill layer is to be laid over a geotextile separation membrane above the clay deposit described in Q2(a). Three layers of this fill, each with a depth of 300 mm and a bulk unit weight of 20 kN m^{-3}, are to be placed, and compacted, over a period of three months. Describe how you could adapt the numerical solution used in Q2(a) to estimate the likely future pore water pressure distribution in the underlying clay layer.

Note: a numerical solution is *not* required: confine your answer to the solution process.

(6 marks)

(Total 25 marks)

Question 3. (25 marks)

An over-consolidated clay soil deposit was found to have the following parameters:

M = 0.78, λ = 0.20, N = 3.50, and Γ = 3.20.

(a) A sample of this soil was isotropically consolidated under cell pressures of 100 kPa, 200 kPa, and 400 kPa. Calculate the mean principal stress at failure, the major principal stress at failure, the deviatoric compression stress at failure and the ultimate voids ratio if the deviatoric compression stage of the test were drained.

(10 marks)

(b) If the same soil was tested under undrained conditions, calculate the mean principal stress at failure, the deviatoric compression stress at failure, and the pore water pressure at failure.

(10 marks)

(c) Analyse the effects of confining pressure σ_3 on your answers to Q3(b).

(5 marks)

(Total 25 marks)

Question 4. (25 marks)

Discuss how an engineer could apply their knowledge of slope stability analysis and earthworks practice to the safe running of the motorway construction site shown in Fig. Q.4.

Fig. Q.4 Motorway construction operations in hard rock overlain by a 2 m stratum of glacial clay.

(Total 25 marks)