UNIVERSITY OF SOUTH AUSTRALIA

SCHOOL OF NATURAL AND BUILT ENVIRONMENTS

JUNE EXAMINATIONS 2004 ROCK AND SOIL MECHANICS (CIVE 3008)

UNIT ONE - SOIL MECHANICS (ALL students)

GENERAL INSTRUCTIONS TO CANDIDATES:	Reading Time: 5 mins
Lecturer: Don Cameron	Exam Duration: 1 hour
1. Attempt all questions on the exam paper	
2. Marks for questions: 2 per question except where noted (total is 40)	
3. Closed book exam	

NAME: **ID:**

I. CONSOLIDATION AND SHEAR STRENGTH

a) How would you best describe "consolidation"?

- ☐ The slow reduction of pore water to a stable state in a saturated soil system due to an external load
- ☐ Long term settlement
- ☐ The drainage of all pore water in a saturated clay or silt due to an applied load
- ☐ The reduction of air voids to strengthen a soil

a) and b) In Figure 1, a consolidation isochrone is shown for a time factor, T, of 0.25. Note that the depth factor Z = z/H.
Answer the following questions relating to the diagram:
b) A point in the centre of a consolidating layer which can only drain from the top of the layer has a consolidation ratio of:

- ☐ 0.32
- ☐ 0.5

c) Estimate how much consolidation settlement would have occurred theoretically by the time corresponding to the time factor of 0.25. Which is the answer closest to your estimate?

- ☐ 33%
- ☐ 42%
- ☐ 58%

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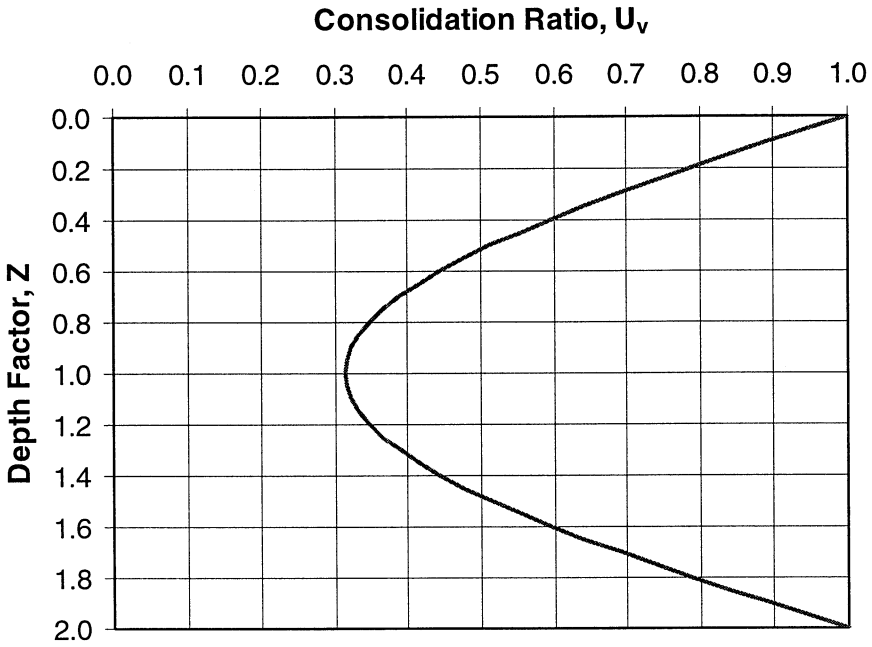

Figure 1. Consolidation Isochrone for T = 0.25

d) A point at 4 m depth in a consolidating soil layer has an initial total vertical stress of 80 kPa and a pore water pressure of 25 kPa. A wide embankment on the soil surface imposes a pressure of 200 kPa. What is the likely effective vertical stress at the end of consolidation below the centre of the embankment?

- ☐ 80 kPa
- ☐ 115 kPa
- ☐ 225 kPa
- ☐ 255 kPa

e) Suggest two methods of accelerating consolidation:

1.

2.

f) and g) The results of direct shear testing have been plotted as indicated in Figure 2. Answer the following questions relating to this Figure:
What are the shear strength parameters for the soil? (to the nearest decimal place)

c (kPa)	

ϕ (°)	

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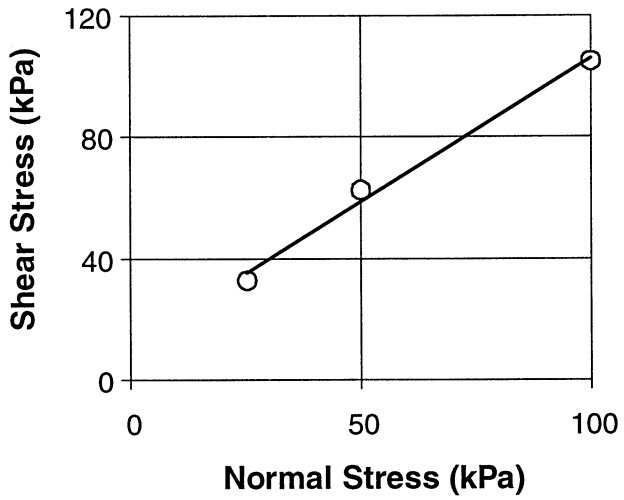

Figure 2. Direct shear test peak strength results

h) and i) A series of triaxial tests have been conducted on a soil, resulting in the 4 Mohr's circles in Figure 3.
What is the likely description of the soil that has been tested?

- ☐ A saturated dense sand
- ☐ An overconsolidated, stiff clay
- ☐ A saturated loose sand
- ☐ A normally consolidated and saturated clay

What type of triaxial test has been performed with respect to drainage?

- ☐ Drained, or
- ☐ Undrained

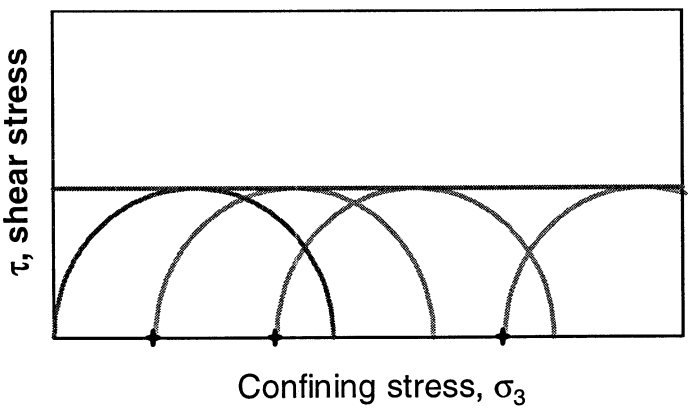

Figure 3. Triaxial test results

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j) Determination of effective stress-shear strength parameters (c′ and ϕ′) for clays and silts generally requires triaxial testing. Suggest 2 reasons why such testing is more time consuming and costly than testing for determination of total stress-shear strength parameters.

1.

2.

II. RETAINING WALLS AND SLOPES STABILITY

a) Behind a gravity retaining wall at a depth of 3 m, the total vertical stress is 50 kPa and the pore water pressure is 10 kPa. What lateral stress is applied to the back of the wall at this same depth by the soil and the water if K_a for the backfill is 0.3?

- ☐ 15 kPa
- ☐ 18 kPa
- ☐ 22 kPa
- ☐ 28 kPa

b) Are clay soils favoured as backfill for retaining walls? Which answer is most accurate?

- ☐ No, clays are too difficult to compact
- ☐ Yes, because no lateral stress is exerted near the top of the wall
- ☐ No, because they are too difficult to drain

c) List 3 engineering requirements of a gravity retaining wall (3 marks):

1.

2.

3.

d) A simple Coulomb wedge is shown behind a gravity retaining wall in Figure 4. Sketch the forces acting on the wedge if the retained soil is a clean granular material ($\phi = 36°$) and wall friction (δ) is to be considered. Make sure you show the directions of each force clearly and indicate what each force is. (5 marks)

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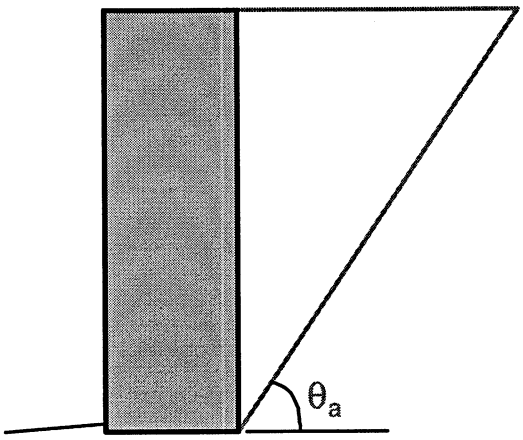

Figure 4. Gravity wall and Coulomb wedge in cohesionless soil

e) Calculate the factor of safety for the slope shown in Figure 5. The slope is in a clay soil, the undrained shear strength of which is 50 kPa (= c_u). (5 marks)
Working:

Answer: Factor of Safety = [ ]

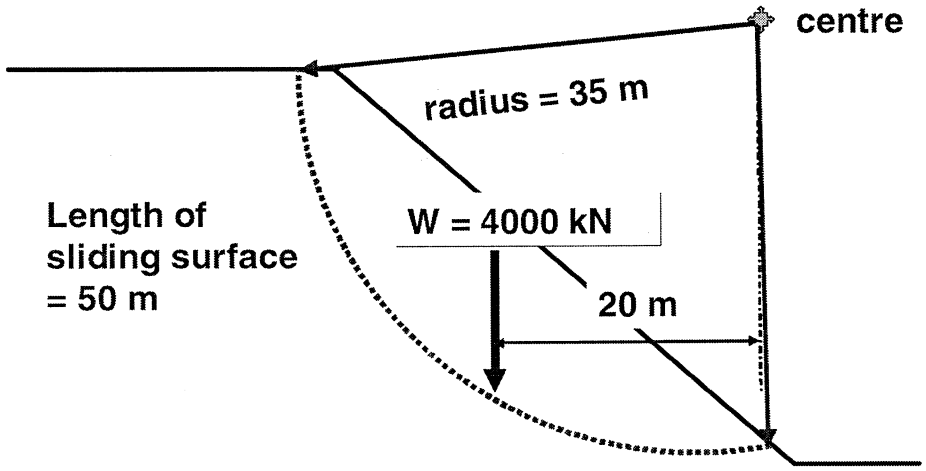

Figure 5. Simple slope stability problem

f) Describe 3 key elements of the method of slices to determine slope stability of a slope in frictional soils, in particular Bishop's simplified method. (3 marks)

1.

2.

3.