Name: _____
Student Number: _____

UNIVERSITY OF TORONTO

FACULTY OF APPLIED SCIENCE AND ENGINEERING

FINAL EXAMINATION, APRIL 2001

Third Year

CIV321H1S - GEOMECHANICS

Exam Type: A

Examiner - K. Klein

Permissible Aids
non-programmable calculator
compass
protractor
ruler

Question	Mark
1	/10
2	/10
3	/10
4	/10
5	/10
TOTAL	**/50**

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1. Short Answer Section

a) What were the most significant results of the direct shear test? (3 marks)

b) In the compaction test, explain what happens to the maximum dry density when the energy of compaction increases. Why? (3 marks)

c) We have studied two second order partial differential equations in this course. What are their "names" and why do we use them? (2 marks)

d) What factors affect the coefficient of permeability of a soil? (1 marks)

e) What is critical state? (1 mark)

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2. Test results shown in Figures 1 and 2 are representative of the compressibility of a 10 m layer of San Francisco Bay Mud (double drainage). The initial void ratio is 2.55.

a) Determine C_c, C_r, and p'_c.
b) What is the ultimate/final consolidation settlement of a large fill on the site if the average total stress increase on the clay layer is 20 kPa?
c) How long will it take the clay to reach 80% consolidation?

$$T = \frac{c_v t}{(H_{dr})^2} \qquad c_v = \frac{0.196\overline{H}_{dr}^2}{t_{50}}$$

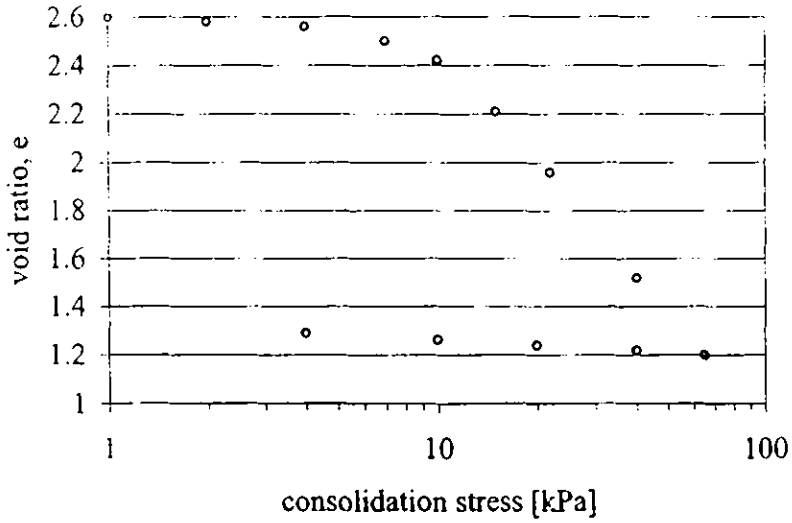

Figure 1 - Consolidation data For San Francisco Bay Mud.

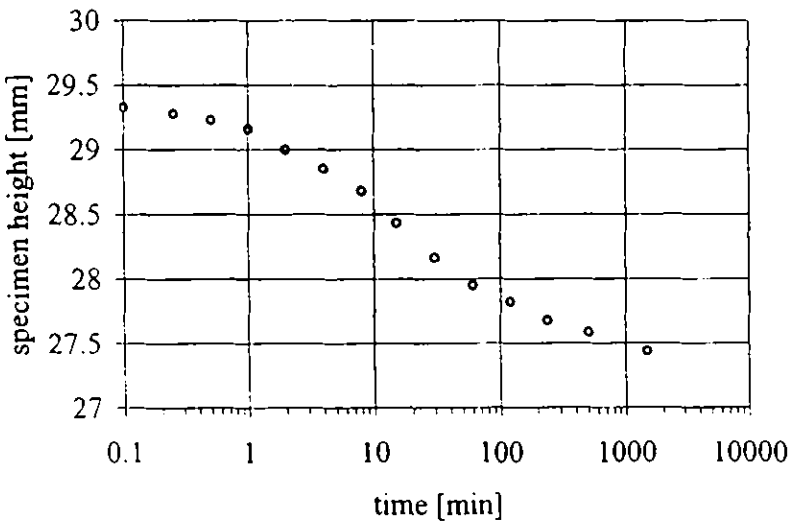

Figure 2 - Log-time plot For San Francisco Bay Mud (double drainage).

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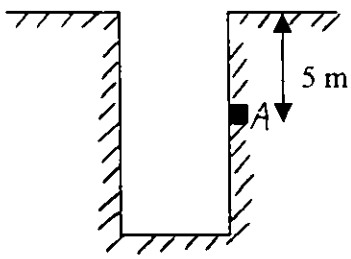
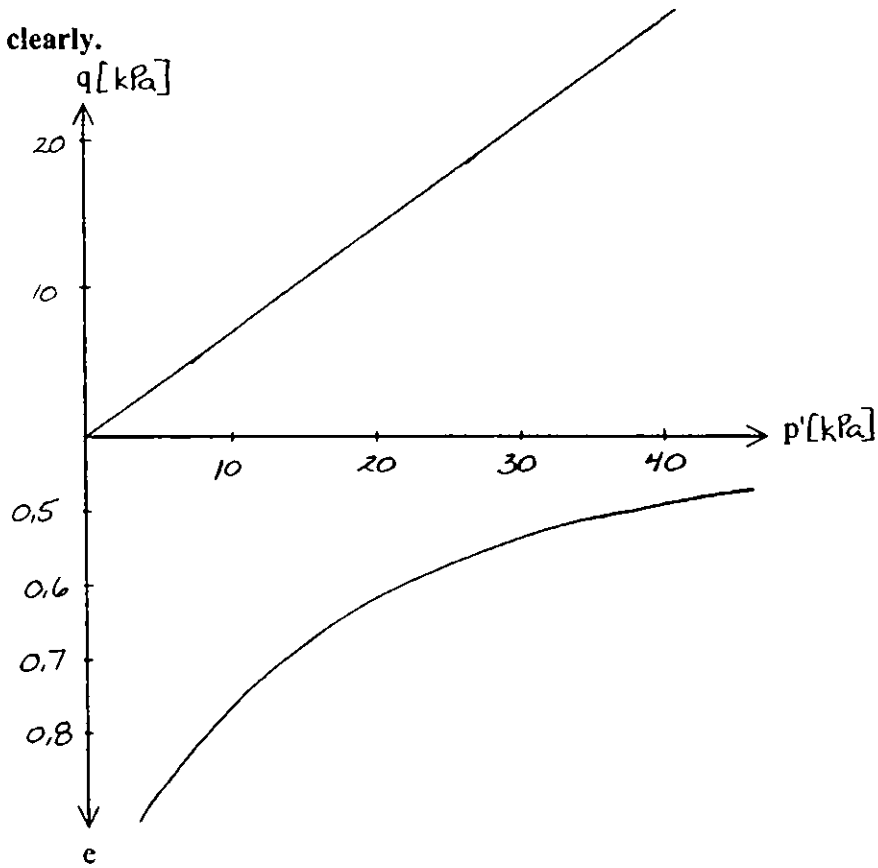
3. For the excavation shown below, answer the following questions:

a) What are the initial (before excavation) vertical and horizontal effective stresses at point A (5 m below ground level)?
b) If the excavation is performed very slowly (drained case), what is the void ratio at which the soil fails?
c) If the excavation is performed very fast (undrained case), what is the excess pore pressure at failure?
d) Is the soil contractive or dilative?

Note: Label the diagram clearly.



γ_{sat}=20 kN/m^3
γ_w=10 kN/m^3
e_o=0.6
K'_o=0.5



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4. A steel storage tank 20 m in diameter will be used to hold a liquid petroleum product. When filled, the tank causes a pressure of 150 kPa. Assume that the stress induced by the empty tank is negligible. The water table is 2 m below the ground surface. For a depth 10 m below the base of the tank, compute the effective vertical and horizontal stresses when the tank is empty and when full, for a point beneath the centre of the tank.

   In order to support this load, what is the minimum friction angle that the soil could have?

   Note: γ_{dry}=18.5 kN/m^3, γ_{sat}=20 kN/m^3, γ_w=10 kN/m^3, K'_o=0.6, and A=0.65.

   $\Delta u = B[\Delta\sigma_3 + A(\Delta\sigma_1 - \Delta\sigma_3)]$

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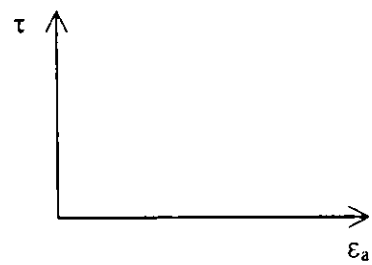
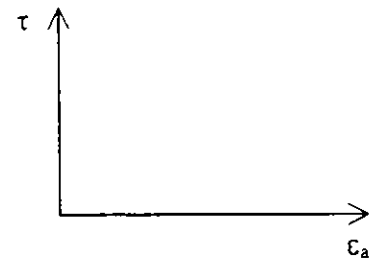
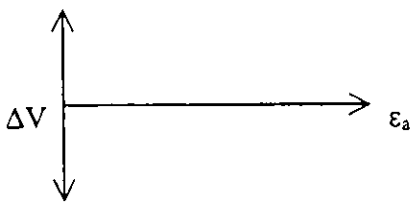
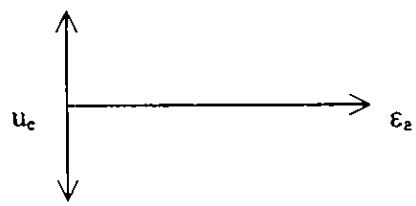
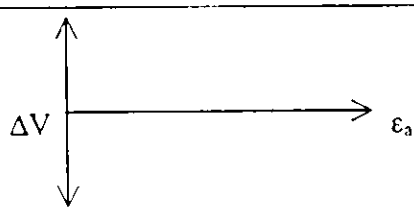
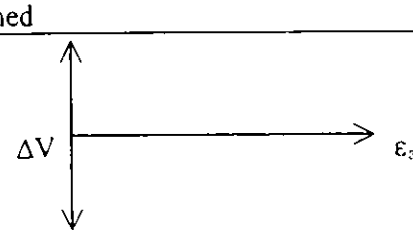
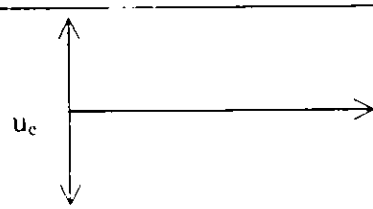
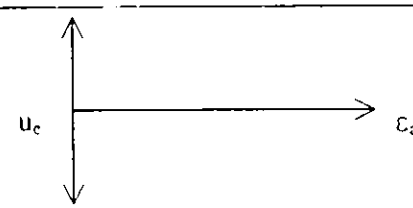
5. Complete the following table. **Be neat and precise. Label important points.**

CONTRACTIVE	DILATIVE
drained	
	
	
	
	
undrained	
	
	

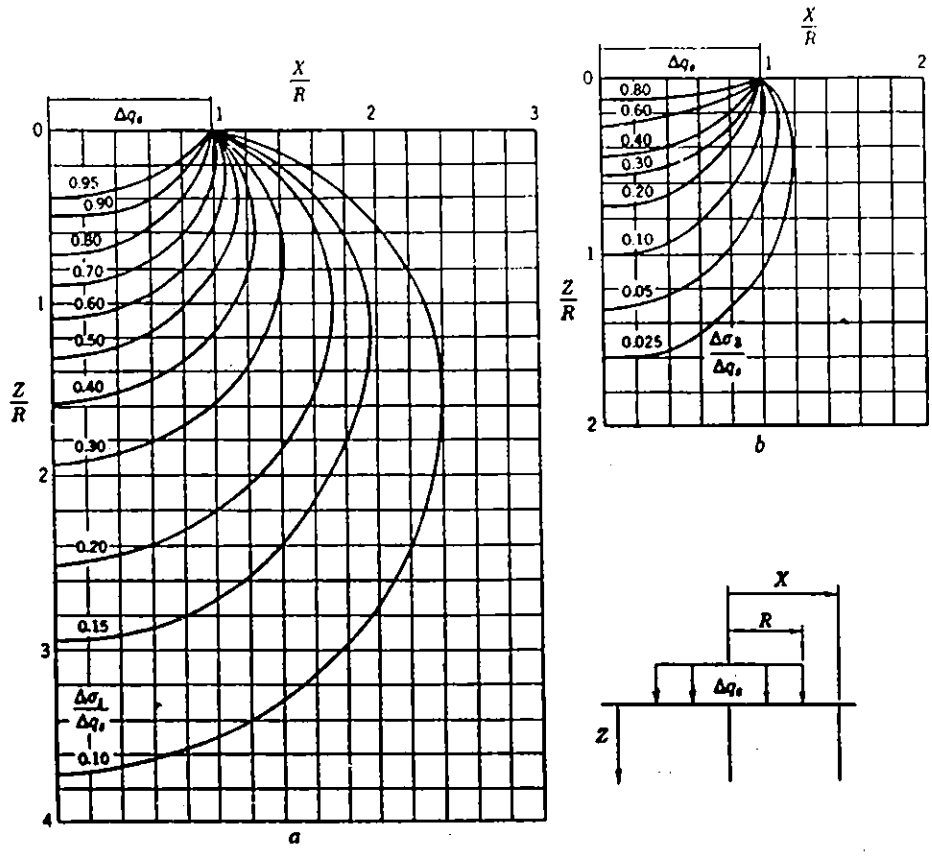


Fig. 8.5 Stresses under uniform load on circular area.
(Lambe+Whitman, 1969)