

National Exams December 2003

98-CIV-A4 Geotechnical Materials and Analysis

3 Hours Duration

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper a clear statement of any assumption made.
2. Type 2 "Closed Book" however, two (2) textbooks maximum are permitted. Written notations in books are acceptable. Drawing instruments and scales are permitted. No notes may be used.
3. Candidate may use one of two calculators, the Casio or Sharp approved models.
4. Graph paper will be provided.
5. There are six (6) questions. **Complete questions 1, 2, 3, 4, and one other question.** Only the first five (5) questions as they appear in your answer book will be marked.
6. All questions are of equal value.
7. **Page #8 must be returned with your examination answer sheets!!!!**

Question 1.

- A.** A tube sample of soil obtained from a borehole had a diameter = 102 mm and length = 610 mm. The soil had a mass of 9.980 kg. The soil had moisture content, $w = 10.5\%$; and specific gravity, $G_s = 2.7$.

Calculate the wet and dry unit weights (in kN/m^3), porosity, and void ratio and degree of saturation. Calculate the water content if the degree of saturation was 100%.

Clearly state any necessary assumptions.

- A.** 1.) From the data below, classify the soils, **Samples B & D**, according to the **USCS**.

Use the "Mechanical Analysis" graph on page #8 for plotting Grain Size Distribution. Be sure to submit page #8 with your answer sheets!

- 2.) What are typical values of minimum and maximum void ratio, e , for these two samples. Explain how you determined these values.

Sieve		Percent Passing					
		Soil Sample					
No.	Size (mm)	A	B	C	D	E	F
4	4.760	100	90	100	100	94	100
8	2.380	97	64	100	90	84	100
10	2.000	92	54	96	77	72	98
20	0.850	87	34	92	59	66	92
40	0.425	53	22	81	51	58	84
60	0.250	42	17	72	42	50	79
100	0.150	26	9	49	35	44	70
200	0.075	17	5	32	33	38	63
Characteristics of minus 40 fraction							
LL (w_L)		35	-	48	46	44	47
PL (w_P)		20	-	26	29	23	24

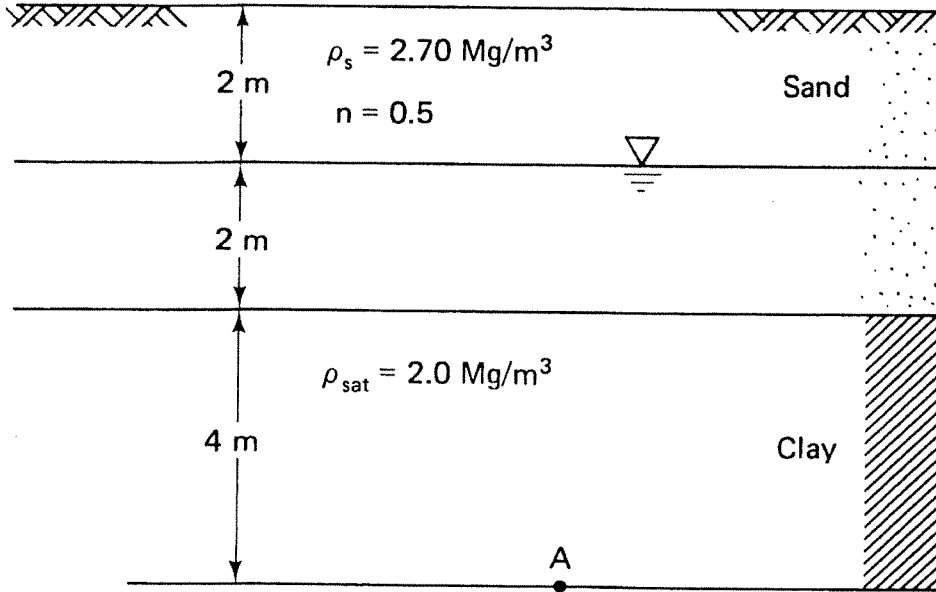
Question 2. For each case illustrated below:

A. PLOT total stress, pore water pressure, and effective stress (in kPa) versus depth (in metres) for the following conditions. These plots should be approximately to scale.

1. Using the soil profile shown below;
2. Using the soil profile shown below, but assume that the water level is raised from 2m below the ground surface to 2m above the ground surface

Note: ρ_s = density of solids;

Clearly state any necessary assumptions.



B. The soil profile beneath a dam consists of four (4) layers. The thickness of each layer and their properties are summarized in the table below.

Determine the equivalent coefficients of permeability in the horizontal and vertical directions.

Thickness, H (m)	Unit Weight (kN/m ³)	k (cm/sec)	
		k_x	k_y
1	17.5	9×10^{-3}	4×10^{-4}
2	18.2	1×10^{-3}	1×10^{-4}
2	18.0	4×10^{-3}	3×10^{-5}
4	18.5	3×10^{-3}	1×10^{-5}

Question 3. The equation of the effective stress Mohr-Coulomb failure envelope for a loose sandy soil from a direct shear test was $\tau_f = \sigma' \tan 33^\circ$.

A consolidated drained (CD), triaxial, lateral compression (LC) test was conducted with the same soil at a chamber confining pressure of $\sigma_3 = 100$ kPa. For this triaxial test:

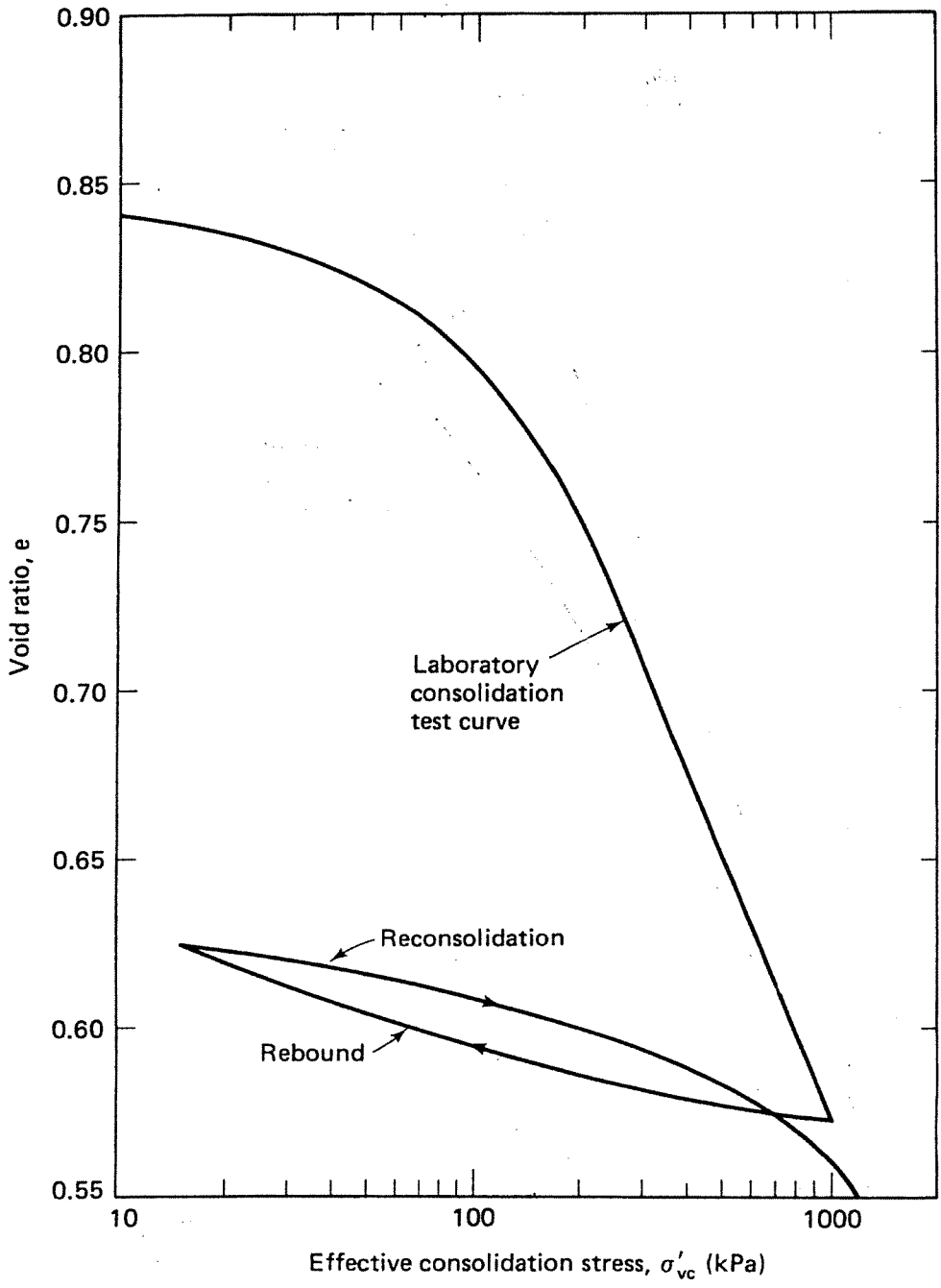
- a) Determine the stresses on the failure plane at failure.
- b) Estimate the angle that the failure plane makes with the major principal plane.
- c) Determine the normal stress and shear stress (at failure) on a plane that makes an angle of 20° with the major principal plane.
- d) Draw the complete Stress Paths (Total & Effective) for this test.
- e) What is the pore water pressure at failure, u_f , for this test?

For the direct shear test, if the applied normal stress at failure, σ_n , was 100 kPa:

- f) Determine the maximum value of shear stress, τ .

Question 4. For the laboratory consolidation test results shown in the figure below:

- B. Find the preconsolidation stress using the 'Casagrande Procedure'.
- C. Determine the over-consolidation ratio (OCR) if the in situ overburden stress is 80 kPa. .
- D. Calculate the consolidation settlement if the soil deposit represented by the consolidation data is 10m thick. Assume that the structural load at the surface increases the average stress in the soil layer by 90 kPa. The initial void ratio of the soil sample was, $e_0 = 0.84$.



Question 6. A load of 2.2 MN is carried on a rectangular footing having width, $B = 2$ m and length, $L = 5$ m. The footing is founded in stiff clay at a depth of 1.5 m below the adjacent ground surface. The water table level is at the base of the footing.

The clay has the following properties:

unit weight, $\gamma = 20$ kN/m³;

unconfined compressive strength, $q_u = 120$ kPa;

effective stress shear strength parameters, $c' = 12$ kPa; $\phi' = 32^\circ$.

- A.** Determine the Factor of Safety with respect to Bearing Capacity.
- B.** What is the additional stress in the soil mass beneath the corner of the footing at a depth of 5.5 m below the ground surface due to the applied footing load?

Question 5.

- A.** The soil conditions for a rigid gravity retaining wall (see figure) are given below. The wall is free to move to the left. The water level behind the wall is at the ground surface. The water level in front of the wall is at the level of the base (bottom) of the wall.

Assume the wall friction is 24° behind the wall and 0° in front of the wall.

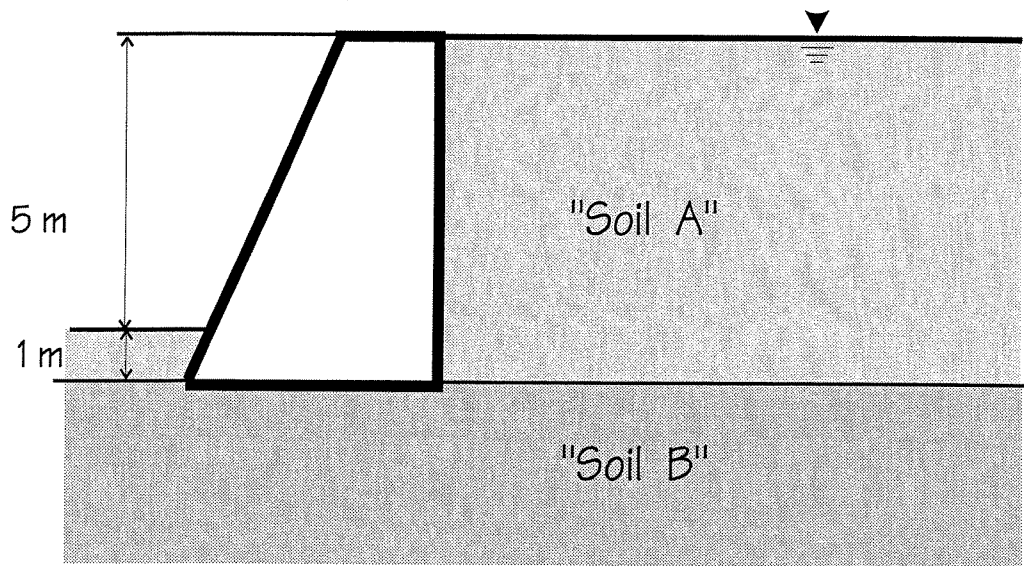
Calculate the lateral earth pressure forces acting on the wall (show the pressure distribution diagrams and forces: include magnitude, direction and locations).

"Soil A" $c' = 0$ kPa ; $\phi' = 36^\circ$; unit weight, $\gamma_{\text{sat}} = 20$ kN/m³ ; $\gamma_{\text{moist}} = 18$ kN/m³

"Soil B" $c' = 20$ kPa; $\phi' = 30^\circ$; unit weight, $\gamma_{\text{sat}} = 18$ kN/m³

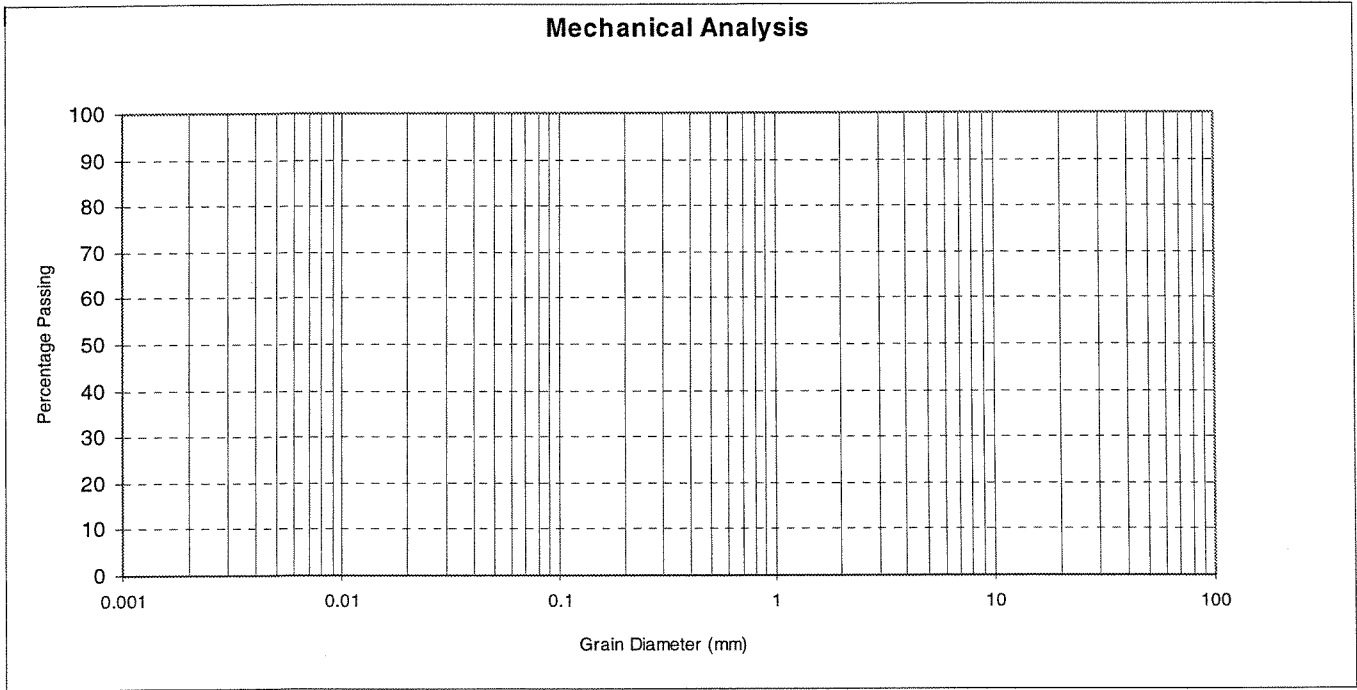
- E.** If the wall cross-section dimensions are: Top = 1m; Base = 3m; is the wall safe with respect to sliding?

Clearly state any necessary assumptions



SUBMIT THIS PAGE WITH YOUR ANSWER SHEETS!!!!

NAME (Print): _____



Graph for Question 1. B.

Grading Scheme

- | | | | | |
|----|----|-----------|----|---------|
| 1. | A. | 6 marks, | | |
| | B. | 14 marks, | | |
| 2. | A. | 12 marks | | |
| | B. | 8 marks | | |
| 3. | a. | 5 marks | d. | 8 marks |
| | b. | 2 marks | e. | 1 marks |
| | a. | 2 marks | f. | 2 marks |
| 4. | A. | 5 marks | | |
| | B. | 12 marks | | |
| | C. | 3 marks | | |
| 5. | A. | 16 marks | | |
| | B. | 4 marks | | |
| 6. | A. | 15 marks | | |
| | B. | 5 marks | | |