National Exams December 2002

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. "Closed Book" - (2) textbooks maximum, no notes may be used. Written notations in books are acceptable.

3. Candidate may use one of two calculators, the Casio or Sharp approved models.

4. Graph paper will be provided.

5. There are 6 questions. **Complete questions 1, 2, 3, 4, and one other question.** Only the first five 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. From the data below, classify the soils, ***Samples A, C, & E***, according to the Unified Soil Classification System (USCS).

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

Sieve No.	Particle Size (mm)	Percent Passing					
		Soil Sample					
		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

B. Determine the dry unit weight and saturated unit weight (in kN/m^3); and the void ratio, porosity, and degree of saturation for a soil sample having a water content, w = 11.2% and total unit weight = 16.9 kN/m^3.
Note: Groundwater Table was at depth = 1 m;

Based on the results above, is this sample a sand, silt, or clay?

Clearly state any necessary assumptions.

Question 2.

You are the field engineer on a grading project. The specification for soil compaction states that the compacted soil in the field must be at least 98%of the Standard Proctor density, and be within (+ or -) 2% of the optimum water content. The results of the laboratory Standard Proctor test is given in the table below.

In the field, you excavate a hole and extract 1.85 kg of soil. The measured volume of the hole was 943 cm^3. You dry 185 g of the soil and the dry sample weighs 155 g.

A. Does the sample meet the required specifications? *(Provide all necessary calculations to verify your answer.)*

B. What is the Degree of Saturation of the compacted soil in the field?

C. If the soil in the field was saturated by adding water *(dry density remains constant)*, what would the moisture content be?

STANDARD PROCTOR TEST RESULTS						
dry density (Mg/m^3)	1.66	1.69	1.71	1.68	1.65	1.61
water content (%)	14.1	15.8	18.2	20.0	22.3	23.8

Use the "Standard Proctor Results" graph on page #8 for plotting. Be sure to submit page #8 with your answer sheets!

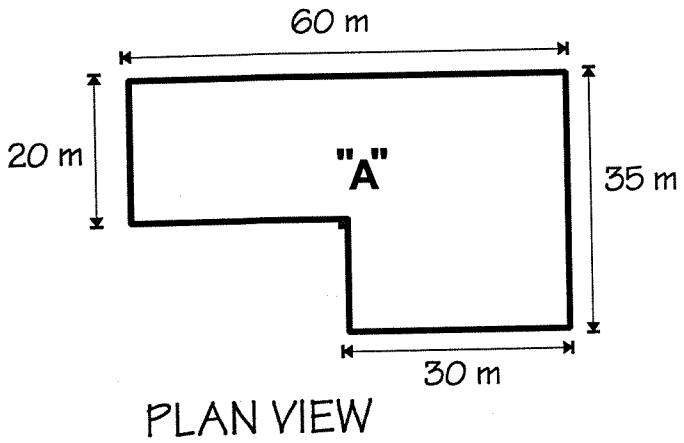
Clearly state any necessary assumptions.

Question 3. A flexible mat foundation and the subsurface conditions at the site are shown below.

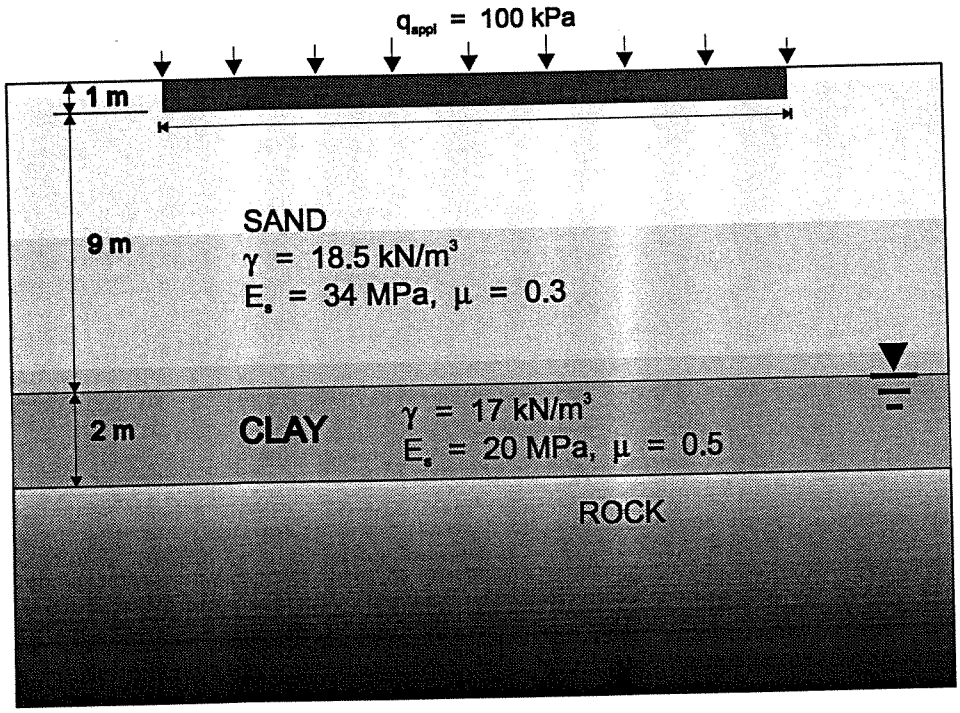
The **applied stress** due to the mat foundation is **100 kPa**.
For a clay sample at depth = 11 m, a laboratory consolidation test gave the following results:
void ratio, **e = 0.88;**
C_c = 0.51; **C_s = 0.05;** **σ'_p = 189 kPa;**
c_v = 2 x 10^{-5} cm^2/sec.

A) Determine the ***maximum total settlement*** beneath ***Point "A"*** of the mat.
Assume: *1) stresses at the centre of the clay layer are representative for the layer;*
2) the bedrock is impermeable.

B) Assume that the ***total consolidation settlement*** was determined to be ***S_c = 1.0 m.***
1) How much consolidation settlement would occur in 2 years and 20 years?
2) How many days would it take for consolidation settlements of 25 and 700 mm to occur?
3) How many days will it take for a consolidation settlement of 1000 mm to occur?



PLAN VIEW



Question 4.

Three identical cylindrical samples of normally consolidated clay (same void ratio, e and water content, w) are subjected to consolidated-drained (CD) triaxial shearing tests. The stresses for the three samples during the testing are shown in the table below.

Triaxial Shearing Test Results			
TEST No..	initial confining stress, σ_c	**Stresses at FAILURE**	
		horizontal stress, σ_{hor}	vertical stress, σ_{ver}
#1	4.7	4.7	11.3
#2	7.6	18.4	7.6
#3	8.3	8.3	3.5

A. Plot the Mohr circles at failure for the CD tests and determine ϕ' and ϕ_{total} from the plots.

B. From the Mohr circle plot determine the inclination of the predicted failure planes for each test. Sketch the failed specimens, showing their failure planes.

C. Plot the stress paths for all three tests. **[Use** $p = (\sigma_{vert} + \sigma_{hor})/2$; $q = (\sigma_{vert} - \sigma_{hor})/2$**]**.

D. What is the pore water pressure at failure for test #3?

Question 5.

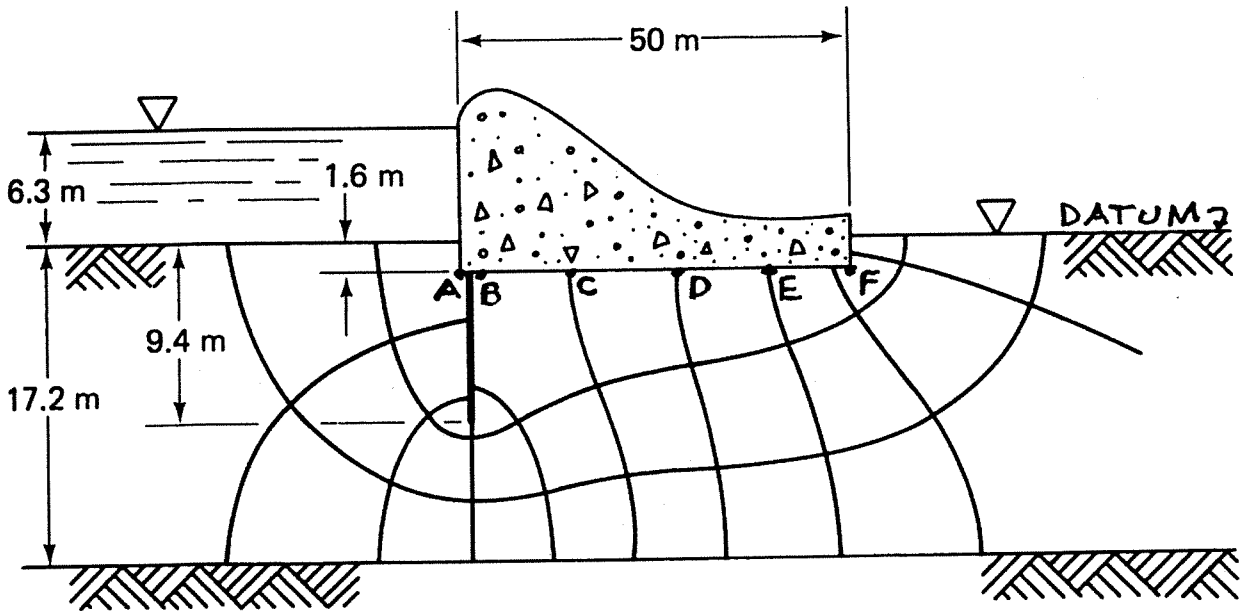
The dam shown below is 100 m long and the coefficient of permeability of the soil is k = 0.045 cm/sec. Using the flow net provided:

A. Plot the pressure, elevation, and total head at each Points "A" through "F".

B. What is the safety factor with respect to uplift?
(Unit weight of concrete, $\gamma_{conc.} = 24\ kN/m^3$)

C. What is the exit gradient?

D. What is the quantity of seepage?



Question 6.

A. Determine the factor of safety for a homogeneous clay slope using the "stability number (or coefficient)" method after Taylor (1937).

Slope Angle, $\beta = 28°$; Height, H = 18 m; Depth to rock, z = 20 m (below toe);

Shear strength, $c_u = 222$ kPa; unit weight, $\gamma = 18.5$ kN/m^3.

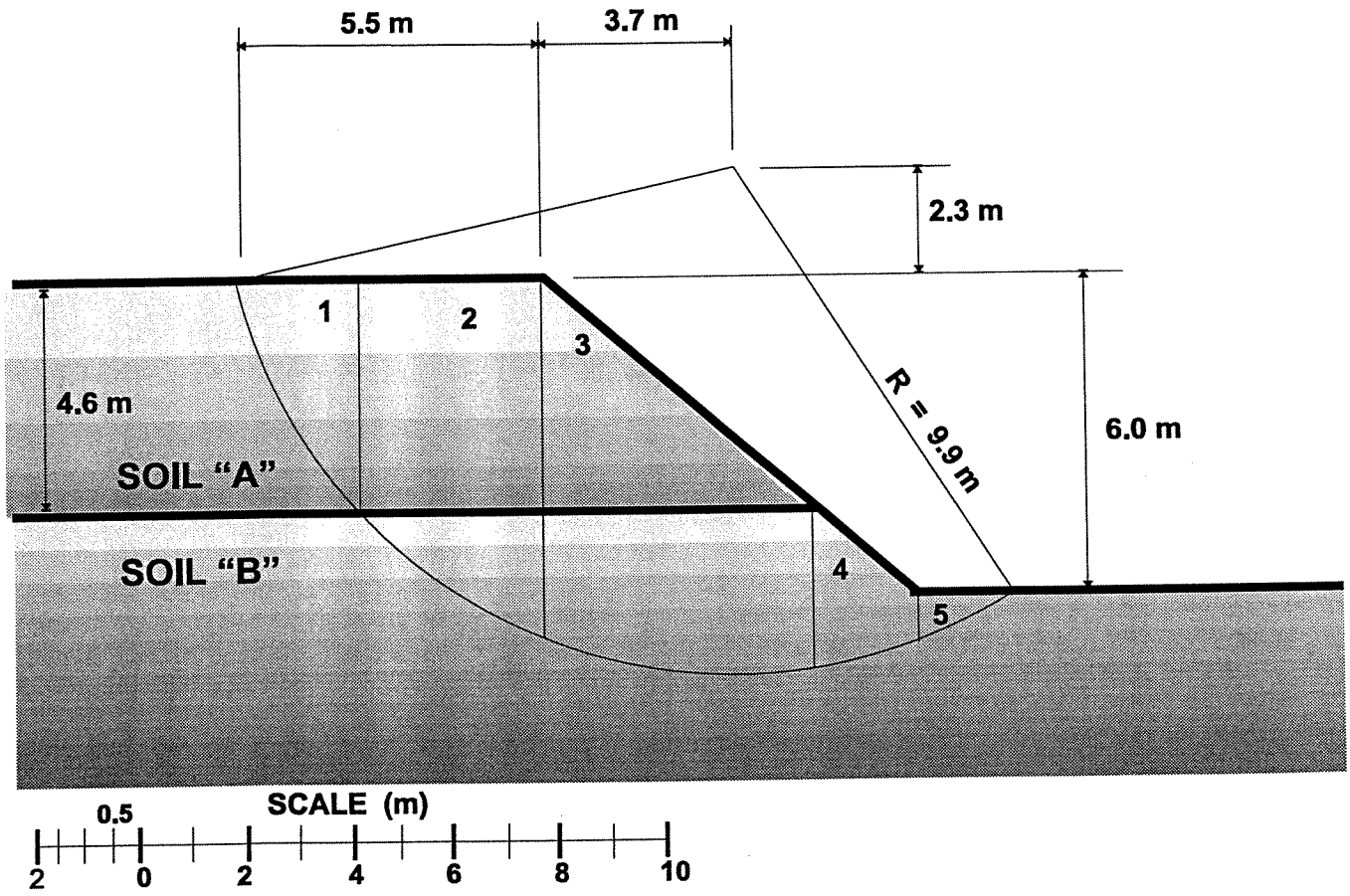
B. Use the Method of Slices (Fellenius/Ordinary) to determine the Factor of Safety for the slope shown below assuming total stress condition.

SOIL PROPERTIES:

SOIL A	
$\gamma_{tot} = 19.0$ kN/m^3	
c' = 0.0 kPa	$\phi' = 25^0$
$c_u = 73$ kPa	

SOIL B	
$\gamma_{tot} = 19.0$ kN/m^3	
c' = 0.0 kPa	$\phi' = 28^0$
$c_u = 97$ kPa	

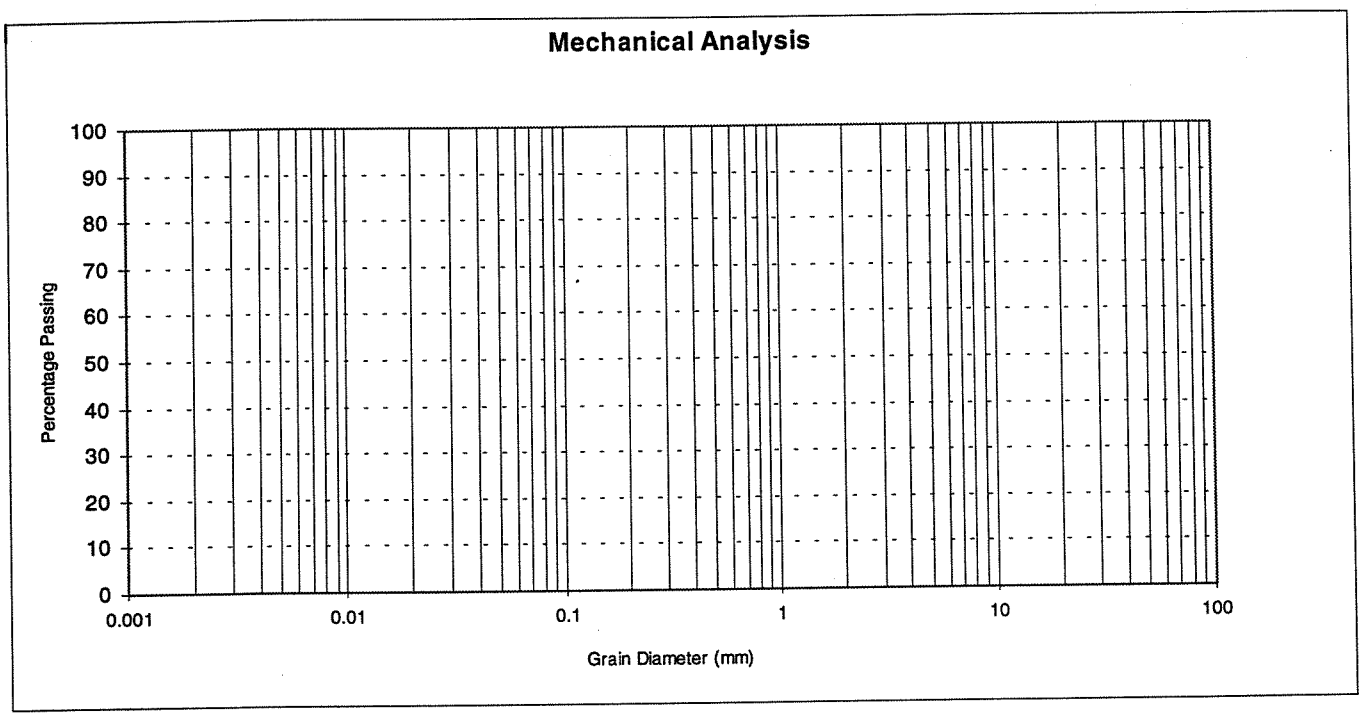
Water table is 2.2 m below toe of slope.



SUBMIT THIS PAGE WITH YOUR ANSWER SHEETS!!!!

NAME (Print): _____

Graph for Question 1. A.



Graph for Question 2. A.