

ELIZADE UNIVERSITY

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

B.Eng (Civil and Environmental Engrg.) Degree 2nd Semester Examination 2018/2019 Session

CVE 510: Geotechnical Engineering

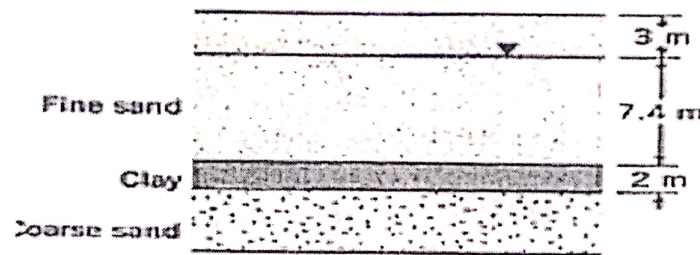
Units: 3

Time Allowed: 3Hrs

INSTRUCTION: Answer FOUR Questions

Question 1 (25 marks)

- (a) The soil profile at a site for a proposed office building consists of a layer of fine sand 10.4m thick above a layer of soft consolidated clay 2m thick (Figure Q1). Below the soft clay is a deposit of coarse sand. The groundwater table was observed at 3m below ground level. The void ratio of the sand is 0.76 and the water content of the clay is 43%. The building will impose a vertical stress increase of 140kPa at the middle of the clay layer. Estimate the primary consolidation settlement of the clay. Assume the clay above the water table to be saturated, $C_c = 0.3$ and $C_v = 2.7$. (16 marks)



Hints:

Figure Q1: Soil profile

$$P_{pc} = \frac{H_0}{1+e_0} C_c \log \frac{\delta_{fin}}{\delta_{zo}}$$

- (b) Define the following terms with respect to soil consolidation:

- i Primary consolidation
- ii, Normally consolidated soil
- iii Modullus of volume compressibility

(9 marks)

Question 2 (25 marks)

- (a) At a vertical stress of 200kPa, the void ratio of a saturated soil sample tested in an oedometer was 1.52 and lied on the normal consolidation line. An increment of vertical stress of 150kPa compressed the sample to a void ratio of 1.43.
- i. Determine the compression index C_c of the soil
 - ii. The sample was unloaded to a vertical stress of 200kPa and the void ratio increased to 1.45, determine the slope of the recompression index C_r .

- iii. What is the overconsolidation ratio of the soil at (ii) above.
 - iv. If the soil reloaded to a vertical stress of 500kPa, what would be the attainable void ratio? (19 marks)
- (b) Outline major shortcomings and merits of direct shear box test. (6 marks)

Question 3 (25 marks)

- (a) Using a well labeled diagram and with all assumptions mentioned, derive Bishop's simplified method of slope stability analysis. (20 marks)

Hint:

$$F = \frac{1}{\sum W \sin \alpha} \sum (c'l + W(\cos \alpha - r_u \sec \alpha) \tan \phi')$$

- (b) Explain the word shear strength of a typical soil found on campus. (5 marks)

Question 4 (25 marks)

- (a) A cutting 10m deep with sides sloping at 8:5 is to be made in a clay soil having a mean undrained strength of 50kN/m² and a mean bulk density of 19.0kN/m³. Determine factor of safety F under immediate (undrained) conditions against slope failure shown in Fig Q4.
- i. If the lower 6m of the bank is submerged.
 - ii. If there is no external water pressure in the bank face.

Assume $Z_c = 1.33\gamma/H$, for the tension cracking. (20 marks)

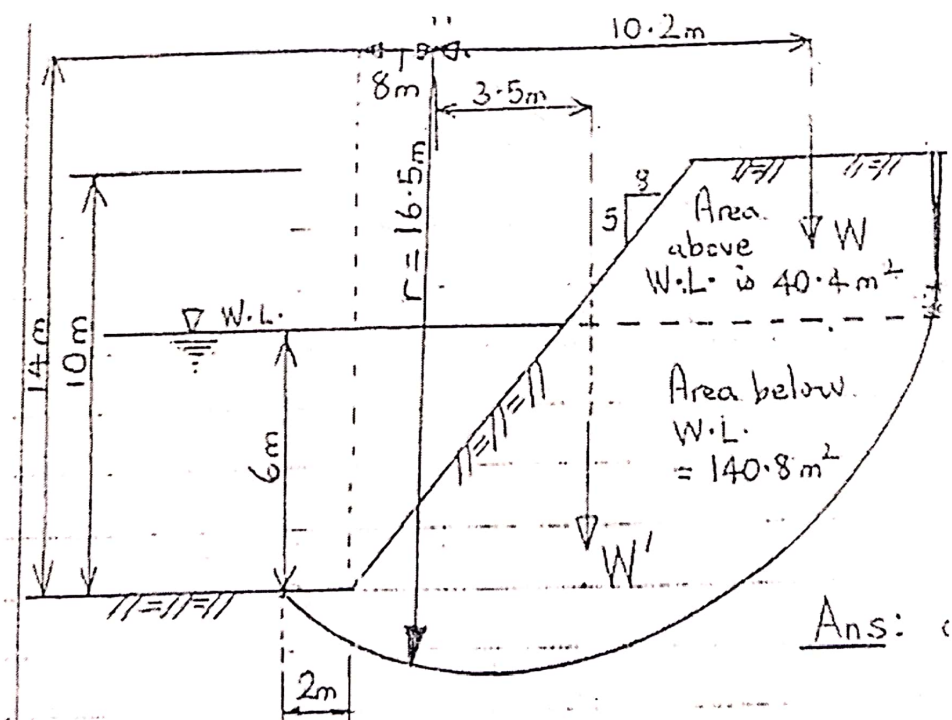


Figure Q4: Embankment slope

- (b) In formulating the concept of one dimensional consolidation, mention assumptions made.

(5 marks)

Question 5 (25 marks)

- (a) A given slope under steady seepage has the following $H = 21.62\text{m}$, $\Phi = 25^\circ$, slope 2H:1V, $c' = 20\text{kN/m}^2$, $\gamma = 18.5\text{kN/m}^3$, $r_u = 0.25$, Determine the factor of safety F_s using the table below. (7 marks)

B(degrees)	Φ (degrees)	$c/\gamma H$	D	m	n
26.57	25	0.05	1.0	1.624	1.338
26.57	25	0.05	1.25	1.595	1.423
26.57	25	0.05	1.5	1.903	1.667

(10 marks)

- (b) Write short note on soil loading history.
- (c) A granular soil has a saturated unit strength of 18kN/m and angle shearing resistance of 30° . A slope is to be made of this material and factor of safety F is to be 1.25. What is the safe angle of slope when:
- i. It is dry or submerged, ii. Seepage occurs at and parallel to the surface. (8 marks)

Question 6 (25 marks)

- (a) The following are the results of four drained direct shear tests of an overconsolidated clay
Dimension of specimen = 50mm; Height of specimen = 25mm
Determine the relationship for peak shear strength τ_f and residual strength τ_r . (10 marks)

Test No	Normal force (N)	Shear force at failure	Residual shear force
		S_{peak} (N)	S_{residual} (N)
1	150	157.5	44.2
2	250	199.9	56.6
3	350	257.6	102.9
4	550	363.4	144.5

- (b) Itemize the procedure of estimating primary consolidation settlement. (8 marks)
- (c) Itemise four events that led to the study of slope stability. (7 marks)