

CVG3109 SOIL MECHANICS FINAL REVIEW

Section I - Multiple choice questions (Circle the correct answer)

Q1.

A fully saturated soil is said to be

- a) one phase system
- b) two phase system with soil and air
- c) two phase system with soil and water
- d) three phase system

Q2.

Which of the following is a measure of particle size range in a soil?

- a) effective size
- b) coefficient of uniformity
- c) coefficient of curvature
- d) none of the above

Q3.

If the natural water content of soil mass lies between its liquid limit and plastic limit, the soil mass is said to be in:

- a) liquid state
- b) plastic state
- c) semi-solid state
- d) solid state

Q4.

Quick sand is a

- a) type of sand
- b) flow condition occurring in fine-grained soils
- c) flow condition occurring in coarse-grained soils
- d) flow condition occurring in both fine- and coarse-grained soils

Q5.

The coefficient of consolidation of a soil is affected by its:

- a) compressibility
- b) permeability
- c) both compressibility and permeability
- d) none of the above

Q6.

In a consolidated drained triaxial compression test on a normally consolidated clay, the volume of the soil sample during shear:

- a) decreases
- b) increases
- c) remains unchanged
- d) first increases and then decreases

Q7.

The shear strength of a soil is a unique function of:

- a) effective stress only
- b) total stress only
- c) both effective stress and total stress
- d) none of the above

Q8.

The Unconfined compressive strength test is:

- a) undrained test
- b) drained test
- c) consolidated undrained test
- d) consolidated drained test

Q9.

If the shear stress is zero on two planes, then the angle between the two planes is:

- a) 45°
- b) 90°
- c) 135°
- d) 225°

Q10.

In a triaxial compression test when drainage is allowed during the first stage (i.e., application of cell pressure) only and not during the subsequent stage (i.e., application of axial stress at constant cell pressure), the test is known as:

- a) consolidated drained test
- b) consolidated undrained test
- c) unconsolidated drained test
- d) unconsolidated undrained test

Section II - Computational Questions

Q11.

A foundation for an oil tank is proposed for a site with a soil profile, as shown in Figure 1. A specimen of the fine-grained soil, 75 mm in diameter and 20 mm thick, was tested in an oedometer in a laboratory. The initial water content was 62% and $G_s=2.7$. The vertical stresses were applied incrementally—each increment remaining on the specimen until the excess pore-water pressure change was negligible.

The cumulative settlement values at the end of each loading step are as follows:

Vertical stress (kPa)	15	30	60	120	240	480
Settlement (mm)	0.10	0.11	0.21	1.13	2.17	3.15

The time–settlement data when the vertical stress was **240 kPa** are:

Time (min)	0	0.25	1	4	9	16	36	64	100
Settlement (mm)	0	0.22	0.42	0.6	0.71	0.79	0.86	0.91	0.93

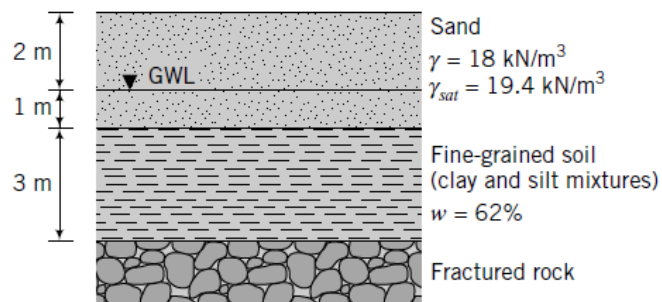


Figure 1

When full the tank will impose vertical stresses of 90 kPa and 75 kPa at the top and bottom of the fine-grained soil layer, respectively. You may assume that the vertical stress is linearly distributed in this layer.

- a) Determine the primary consolidation settlement of the fine-grained soil layer when the tank is full.
- b) Calculate and plot the settlement versus time curve.

Solution:

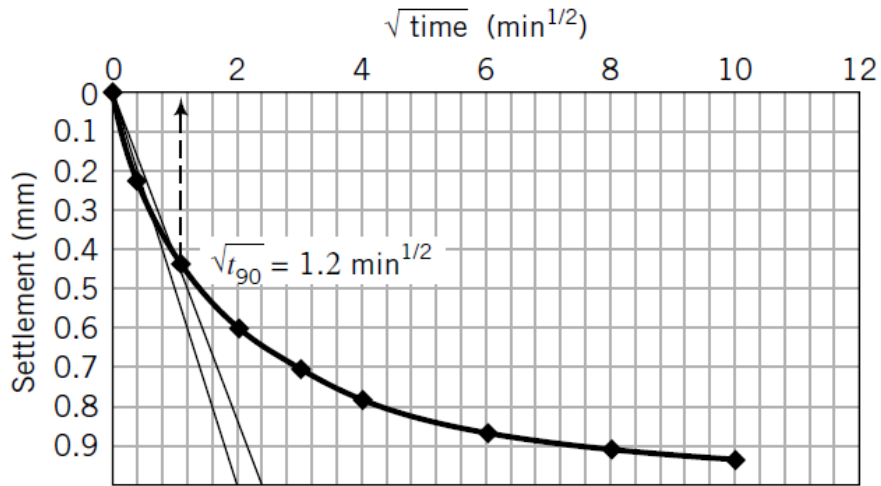


Figure 2

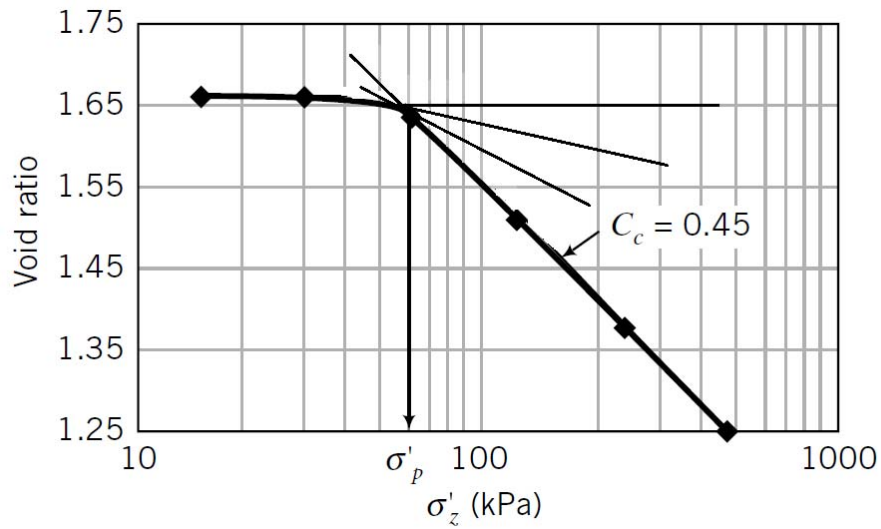


Figure 3

Layer	z (m)	σ'_{z0} at center of sublayer (kPa)	$\Delta\sigma_z$ (kPa)	$\sigma'_{z0} + \Delta\sigma_z$ (kPa)	S_i (mm)
1	0.5	48.7	87.5	136.2	75.9
2	1.5	54.9	82.5	137.4	67.7
3	2.5	61.1	77.5	138.6	60.5
Total					204.1

U (%)	Settlement (mm)		
	T_v	$S_c \times \frac{U}{100}$	$t = 26.2 T_v$ (days)
10	0.008	20.4	0.2
20	0.031	20.8	0.8
30	0.071	61.3	1.9
40	0.126	81.6	3.3
50	0.197	102.1	5.2
60	0.287	122.5	7.6
70	0.403	142.9	10.6
80	0.567	163.3	14.9
90	0.848	183.7	22.3

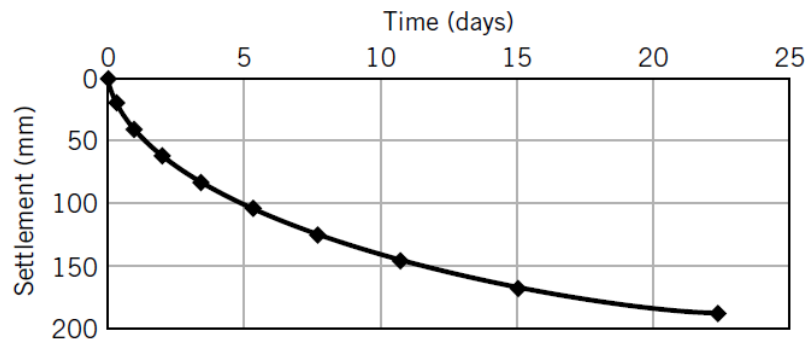


Figure 4

Q12.

The stresses acting on a soil element are shown in Figure 5. Plot the Mohr Circle and determine:

- the magnitude of the major and the minor principal stresses and the orientation of the two principal planes.
- the normal stress, σ_α and the shear stress, τ_α on the horizontal C plane, as shown in Figure 5.
- Describe the steps in the graphical solution for a) and b).

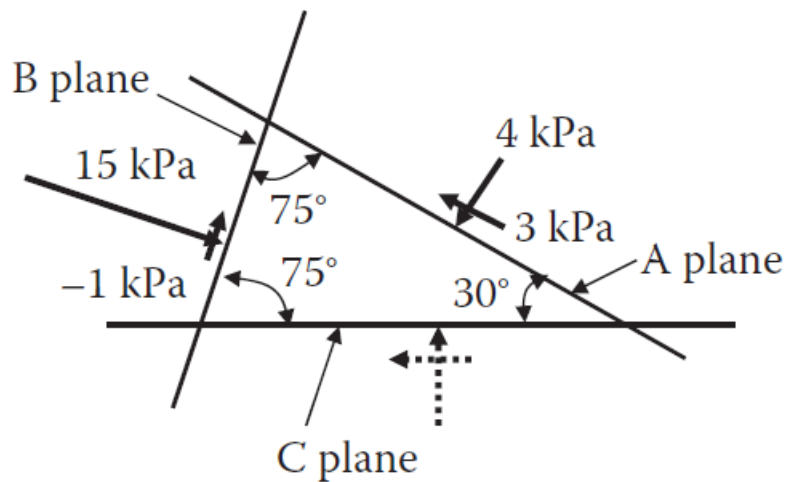


Figure 5

Solution:

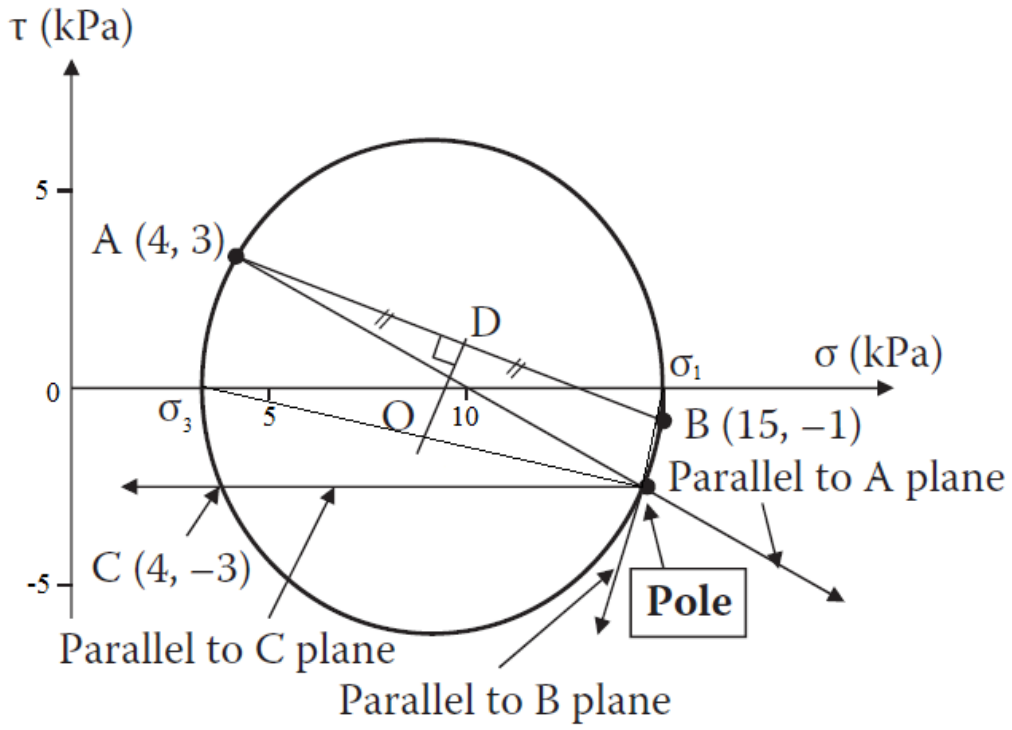


Figure 6

Q13.

A rectangular foundation 4 m x 5 m transmits a total load of 5 MN to a deep, uniform deposit of stiff, overconsolidated clay with an $OCR = 4$ and $\gamma_{sat} = 18 \text{ kN/m}^3$ (Figure 7). Groundwater level is at 1 m below the ground surface. A CU test was conducted on a soil sample taken at a depth 5 m below the center of the foundation. The results obtained are $S_u = 40 \text{ kPa}$, $c' = 0$, and $\phi' = 24^\circ$. Assume the soil above the groundwater level is saturated and,

- Determine if the soil will reach the failure state for short-term and long-term loading conditions.
- If the soil does not reach the failure state, what are the factors of safety for short-term and long-term loading conditions?

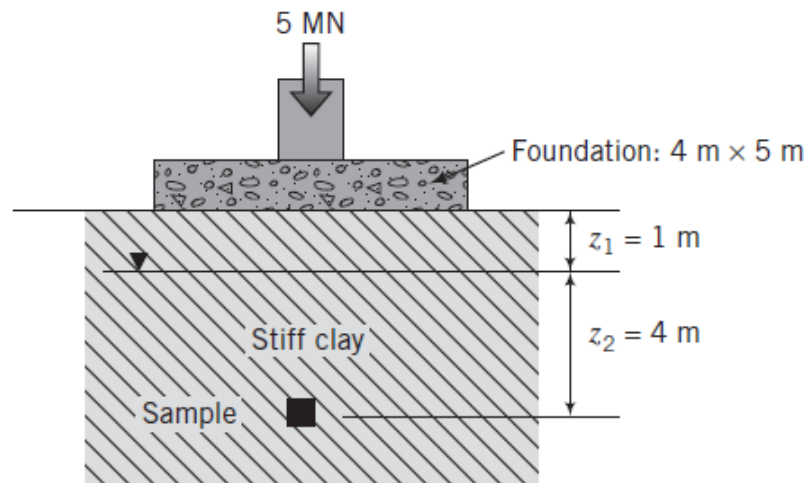


Figure 7