2019 Soil Mechanics I and Exercises Midterm Exam

2019/11/26 (Tue) 13:00-14:00 W2 Lecture room

Attention:

- The exam consists of two questions for which you are provided with two answer sheets. Write down your name and ID number on every answer sheet. Use one answer sheet per question and answer them in sequence, starting from [Question 1]. If the front page of an answer sheet is insufficient to complete your answer, use the back page of the same answer sheet after clearly indicating your intent.
- Scores for each question are equally weighted.
- In addition to personal writing instruments, non-programmable calculators are permitted. However, programmable calculators and calculator functions of mobile phones are prohibited. Any attempts at cheating on the exam will result in failed credit of the course and serious penalties.
- Wherever necessary, specify the units in your answers.

[Question 1] Answer the following questions.

1) Describe the definitions and provide concise explanations of the following terms.
   (1) Plasticity index
   (2) Uniformity coefficient
   (3) Relative density

2) Answer the following questions for the ground shown in Figure 1 using the quantities given in the figure. Note that the ground below ground water level is assumed to be fully saturated.
   (1) When the ground water level is located at the surface, find the vertical total stress σ_v, the vertical effective stress σ'_v, and the pore water pressure at point P.
   (2) Find the void ratio of the sand layer.
   (3) Ground water level draws down to 3m below the ground surface. Find the vertical total stress σ_v, the vertical effective stress σ'_v, and the pore water pressure at point P after the drawdown.
   (4) Find the water content and degree of saturation of the sand layer located above the ground water level. Assume that the void ratio does not change even after the drawdown.

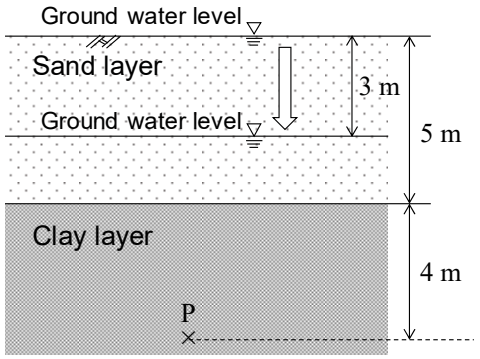

Figure 1

3) An embankment is planned to be constructed using soil with a volume of 100,000 m^3. At the excavation site, the soil has γ_t = 14.4 kN/m^3 and w =17.0%. This soil is to be compacted to obtain γ_d =16.2 kN/m^3. Assume

that the specific gravity of the soil G_s =2.70 and the unit weight of water γ_w = 9.81 kN/m^3.

(1) Explain optimum water content and maximum dry density. Figures might be drawn if necessary.

(2) Find the volume and the weight of soil to be excavated from the excavation site.

(3) Calculate the degree of saturation of this soil after the compaction.

[Question 2]

The permeability tests were performed for undisturbed soil collected at a site, which has a cross-sectional area A = 80 cm^2 and a degree of saturation S_r = 60%. The tests were performed after full saturation of a specimen. Answer the following questions using the unit weight of water as 9.81 kN/m^3.

1) From the constant head permeability test shown in Fig. 2, the amount of water flow Q = 60.0 cm^3 was observed for 1000 seconds permeation. Find the permeability coefficient of this soil column with 2 significant digits. Assume that the soil column is supported by mesh.

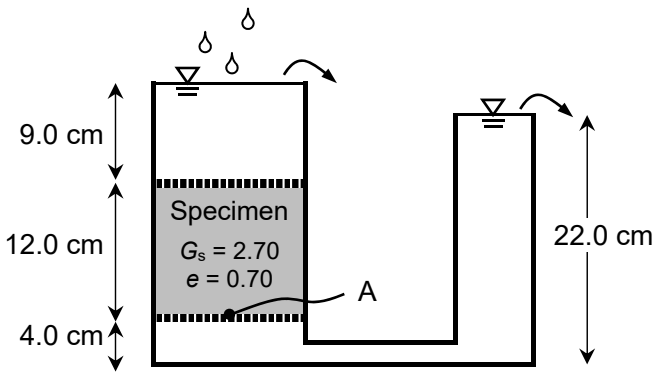

Figure 2

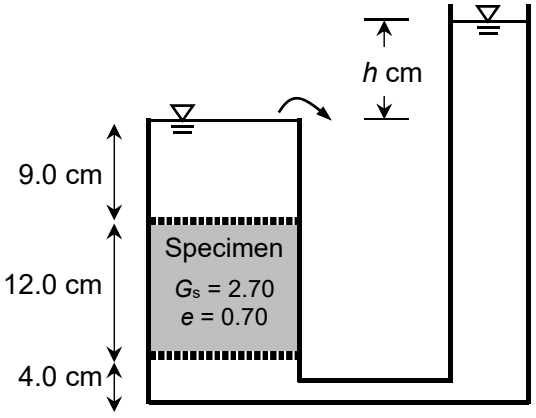

Figure 3

2) Determine the vertical total stress σ_v, and the vertical effective stress σ'_v, at location A along the bottom of the soil specimen in Fig. 2.

3) The right pipe of the system in Fig. 2 was replaced with a sufficiently long standpipe, as shown in Fig. 3, to perform the falling head permeability test. Derive the equation to express the permeability coefficient of soil determined by the falling head permeability test, using the following parameters.

k : Permeability coefficient of soil (m/s) a : Cross-sectional area of standpipe (cm^2)

L : Length of specimen (cm) A : Cross-sectional area of specimen (cm^2)

h_1 : Difference of head at $t = t_1$ (cm) h_2 : Difference of head at $t = t_2$ (cm)

$t_2 - t_1$: Measurement time (s)

4) The permeability coefficient of the soil determined by the constant head permeability test is taken to be the same as that obtained from the falling head permeability test. When the value of each parameter defined in 3) can be given as follows, find the measurement time, $t_2 - t_1$ (s).

a : 20 cm^2, L : 12.0 cm, A : 80 cm^2, h_1 : 11.0 cm, h_2 : 8.0 cm

5) Show necessary condition about difference of head, h (cm), in order to avoid quicksand condition in the specimen.