2016 - Soil Mechanics I and Exercises - Midterm Examination

2016/11/29 (Tue) 13:00-14:00 W2 Lecture Room

Attention:

- There are two answer sheets for two questions including sub-questions. Write down your name and student ID number on both answer sheets. Use one answer sheet for one question and answer them in the same order as the questions are posed, starting from [Question 1]. If the space provided in the answer sheet is insufficient, use the back page after clearly mentioning so (for example, "continued on back page").
- In addition to writing utensils, rulers and scientific calculators are allowed on the exam. However, programmable calculators or mobile phone calculators/applications are absolutely not permitted.
- Talking is not allowed at any time in the test. Any attempts at cheating on the test will result in failed credit of the course and serious penalties.
- Wherever necessary, specify the units in your answers.

[Question 1] Answer the questions below.

(1) Answer the following questions regarding the ground shown in Figure 1, using the density of water $\rho_w = 1.00\times10^3$ kg/m^3 and the acceleration of gravity $g = 9.80$ m/s^2.

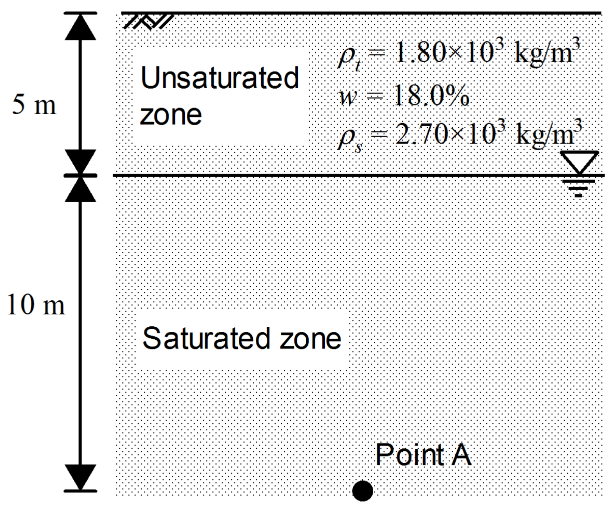

Figure 1

1) Soil experiments were carried out on the undisturbed samples taken from the ground above the groundwater surface (unsaturated zone), giving the water content w = 18.0%, the total density of soil ρ_t =1.80×10^3 kg/m^3 and the particle density of soil ρ_s =2.70×10^3 kg/m^3. Find the void ratio e and the degree of saturation S_r of this ground.

2) Assuming that the ground below the groundwater surface (saturated zone) is fully saturated, find the water content w and the wet (saturated) density of soil ρ_{sat} in the saturated zone. Provided that the void ratio e and the soil particle density ρ_s do not change along the depth, the values obtained from 1) may be used.

3) Under the condition described in Figure 1, calculate total stress, pore water pressure and effective stress at Point A (15 m deep from the ground surface).

(2) Explain briefly the following subjects and how they are obtained and measured in the experiments.
   1) Soil compaction curve
   2) Liquid limit
   3) Soil particle density

[Question 2] Answer the following questions regarding flow of water through soils. Consider all soil samples as fully saturated, and that the flow of water follows Darcy's Law.

(1) As shown in Figure 2, the soil sample 1 is set in a permeability test apparatus. The cross section of the sample is 2.0×10^{-2} m^2, and its lower part is supported by a metallic mesh. The hydraulic conductivity of soil 1 is $k_1 = 3.0 \times 10^{-5}$ m/s. Find the flow rate through the system, given the head difference shown in the figure.

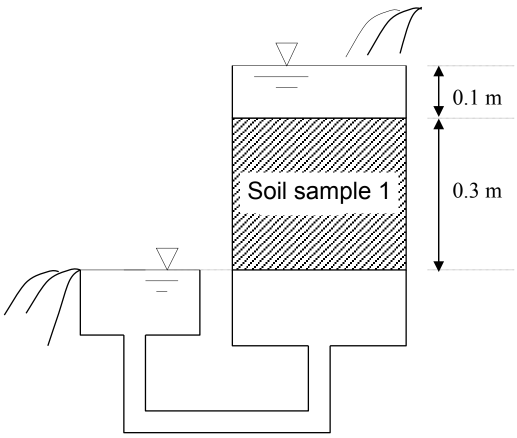

Figure 2

(2) As shown in Figure 3, the soil sample 2, with a thickness of 0.1 m and a hydraulic conductivity of 1.0×10^{-5} m/s, overlays a 0.2 m sample of soil 1, similar to that described in (1). Once the system reaches a steady state, find the water flow velocity in soil 1, as well as the total head at the boundary between soil 1 and soil 2. Assume, for this problem, that the datum is located at the bottom of soil 1.

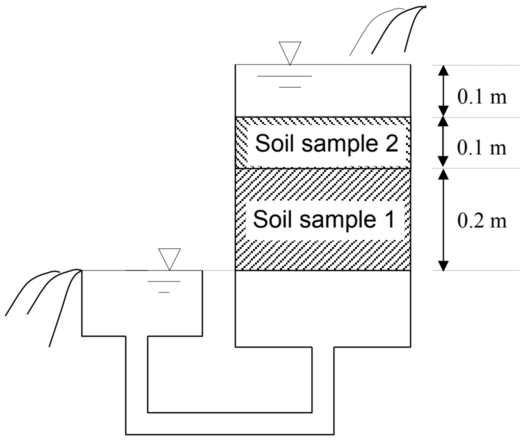

Figure 3

(3) Plot the total head, the potential head, and the pressure head distributions of question (2). Assume that the datum is located at the bottom of soil 1.