2012 Soil Mechanics I and Exercises Midterm Examination

2012/11/20 (Tue) 13:00~14:00 Kyotsu 155・Kyotsu 1・Kyotsu 3・W2 Lecture room

Attention:

- There are two questions and two answer sheets. Write down your name and ID number on both of those answer sheets. Use one answer sheet for one question and answer in sequence from 【Question 1】. If the front side of the answer sheet is not sufficient for answering that question, mention that and use the back side of that answer sheet.
- Carrying any personal belongings is prohibited. For any mischievous act, you will not be entitled to get the credit of this subject.
- Wherever necessary, show the units in your answers.

【Question 1】Answer the following questions related to soil index properties.

(1) Figure 1 shows the ground conditions at a site of concern. The density of water is w = 1,000 kg/m^3 and gravitational acceleration is g = 9.8 m/s^2.

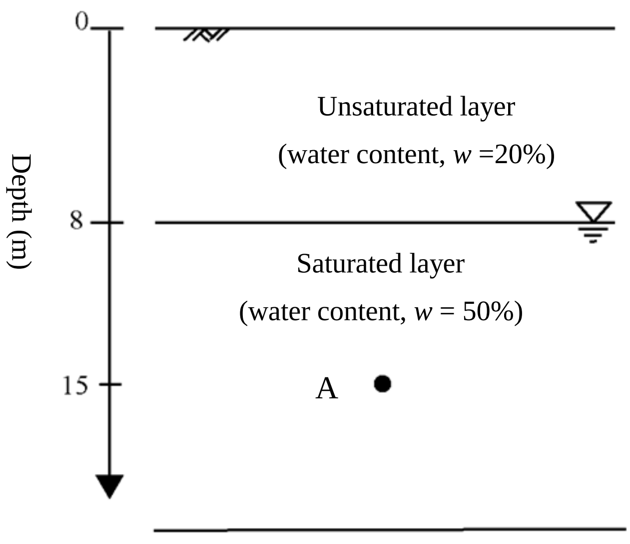


Fig. 1 Ground conditions

1. A core of saturated soil sampled from soil layer below the water table (saturated layer) had the water content, w = 50% and the wet bulk density, ρ_t=1,750 kg/m^3. Find the void ratio (e) and the density of soil solids (ρ_s).
2. If the water content of the soil ground above the water table (unsaturated layer) was 20%, then find the wet bulk density of the soil ground above the water table. Assume that there is no change in the void ratio and the density of soil solids throughout the depth of the soil ground. For these parameters, use the values obtained in the previous question (1).
3. Find the total vertical stress, the pore water pressure and the effective vertical stress at the location A shown in Fig. 1.

(2) What are the effects of the following factors on the soil compaction behavior (the optimum moisture content, the maximum dry density)? Also, explain the reasons. If necessary, draw the figures.

1. Increment in the compaction energy.
2. Increment in the uniformity coefficient (soil having good grain size distribution curve).

【Question 2】Answer the following questions related to the permeability of soils.

(1) The constant head permeability test under the condition of the difference in the total head, h=20cm is conducted as shown in Fig. 2. The length of the sand specimen is 20cm. ① Find the critical hydraulic gradient, i_c. ② Find the necessary difference in the total head, h for the occurrence of quicksand.

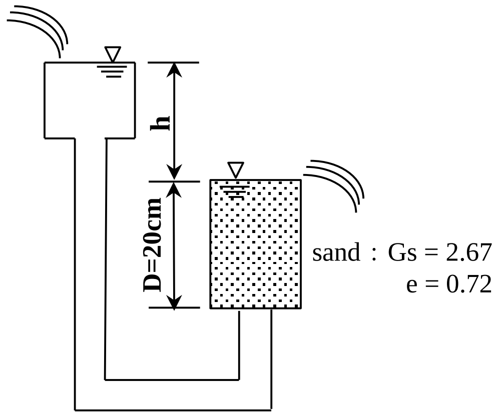


Fig. 2

(2) Consider the specimen consisting of two types of layers in parallel series, where two different soil layers are connected in series and the independent single soil layer are filled in as shown in Fig. 3. The lateral boundary of the layer is assumed to be impermeable. The thickness of the individual layers in series on the left-hand side is H_1 and H_2 with the width of L_1. The thickness of the single layer on the right-hand side is H_1+H_2 with the width of L_2. The values of the coefficient of permeability of the corresponding layers are assumed to be k_1, k_2 and k_3 as shown in Fig. 3. By assuming that the water flows uniformly in the soil specimen in the vertical direction, find the equivalent coefficient of permeability, k_v for this soil specimen consisting of three different soils.

Let us set that $H_1 = L_1$ =20cm, $H_2 = L_2$ =10cm, k_1 =2.0x10^{-2}cm/s, k_2 =5.0x10^{-4}cm/s, k_3 =1.0x10^{-3}cm/s. When the difference in total head of 30cm is applied between the top and the bottom of the specimen, find the total volume of water in a unit width (perpendicular to the figure) of 1cm flowing in the specimen in an hour.

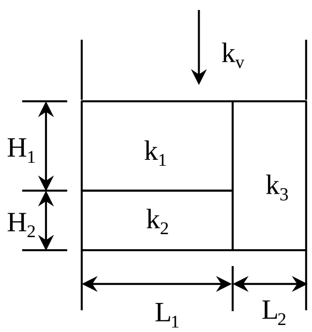


Fig. 3

2013 Soil Mechanics I and Exercise Mid-term Examination

2013/11/26 (Tue.) 13:00～14:00 Room: W2

Attention:

- There are two questions and 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 side of an answer sheet is not enough for answering one specific question, you can use the back side of the same answer sheet, after clearly mentioning so. All questions bear equal mark.
- Non-programmable calculators are permitted, but calculators that have programming functions and all types of mobile phones are prohibited. In addition, rulers are permitted to draw straight lines and measure distances.
- If you behave maliciously during the exam, you will not be entitled to get any credit on this subject.
- Wherever necessary, show the units in your answers.

【1】 In order to construct an embankment for the express way, a test embankment shown in Fig. 1 is made by bringing the soil from the excavation site. This test embankment is assumed to have the dry density of ρ_d = 1.6 g/cm^3. The upper and lower surfaces of this embankment are rectangular in shape having dimensions: A = 8 m, B = 12 m, a = 2 m, b = 6 m, h = 2.5 m. The soil at the excavation site has soil particle density, ρ_s = 2.5 g/cm^3 (i.e., specific gravity, G_s = 2.5), water content, w = 20%, and bulk density, ρ_t = 1.8 g/cm^3. At this condition, calculate the following parameters:

(1) Dry density of the soil at the excavation site.
(2) Void ratio of the soil at the excavation site.
(3) Degree of saturation of the soil at the excavation site.
(4) Total weight of the soil to be excavated from the excavation site.
(5) Total volume of the soil to be excavated from the excavation site.

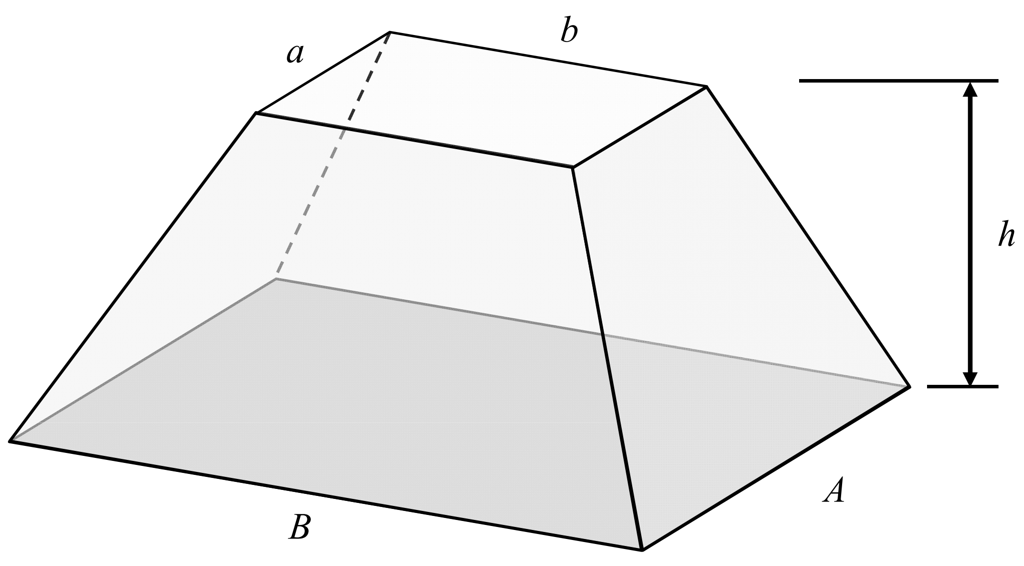
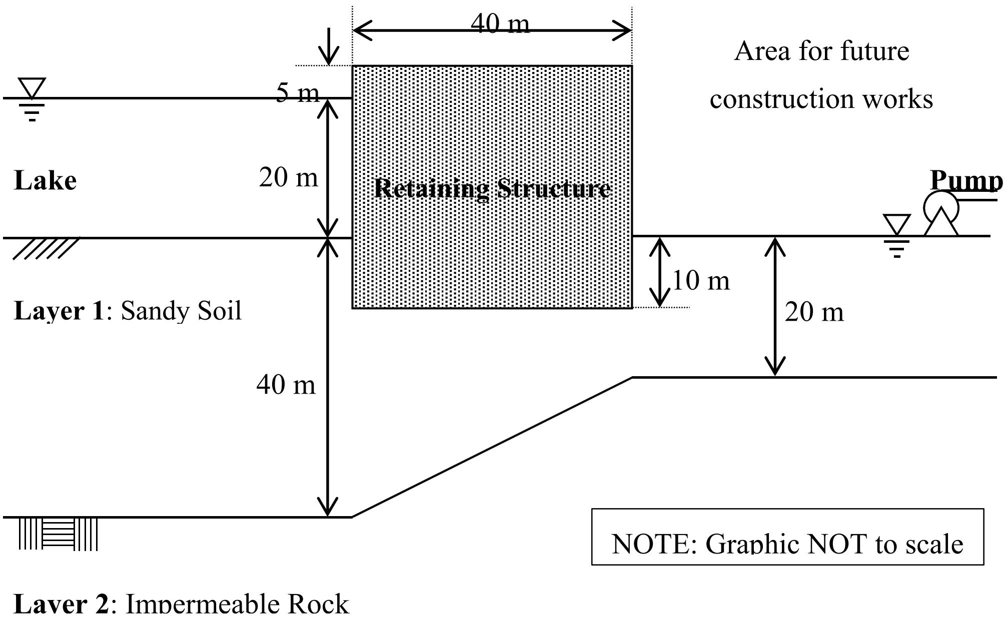


Fig. 1

【2】 Answer the following questions related to soil permeability and flow of water through soils.

(1) In the following graphic (not to scale), Layer 1 is an isotropic soil with a hydraulic conductivity of $k = 4.0 \times 10^{-4}$ m/s. Layer 2 is an impermeable rock. A retaining structure, which can be considered of infinite length in the direction perpendicular to the graphic for the purpose of this analysis, was installed to allow for the creation of a dry space next to a lake of 20 m depth, required for the future construction of certain civil structures. To keep this dry space adequately devoid of water, heavy duty pumps with a pumping capacity of 400 liters per minute will be installed in this area.

With this information in mind, answer questions (a) through (d):



(a) Calculate the rate of seepage under the **retaining structure**.

(b) Calculate the maximum allowed spacing between **pumps**, in meters, in the direction perpendicular to the graphic, to account for all this seepage.

(c) Calculate the uplift force at the base of the **retaining structure** per meter of length (in the direction perpendicular to the graphic). Assume water density as ρ_w = 1000 kg/m^3, and gravitational acceleration as g = 9.8 m/s^2.

(d) Calculate the required minimum density ρ of the **retaining structure** if we want to assure that the flotation factor of safety, defined as $FS = \frac{\text{Weight of structure}}{\text{Uplift force}}$, is equal or greater than 3.0.

(2) In five lines or less (you can include graphics if necessary) explain:

(a) the mechanism of quicksand, and

(b) how to calculate the quicksand critical hydraulic gradient.

2014 Soil Mechanics I and Exercises Midterm Exam

2014/12/2 (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, scientific calculators are allowed on the exam. However, programmable calculators or mobile phone calculators/applications are absolutely not permitted. 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 to the following questions related to the physical properties of soil.

(1) Sieve analysis of Silica sand no.6 was conducted. Based on the particle size distribution curve shown in Figure 1, find the average particle diameter D_{50} (the soil diameter at which 50% of the soil weight is finer) and the uniformity coefficient U_c associated with the slope of the grading curve.

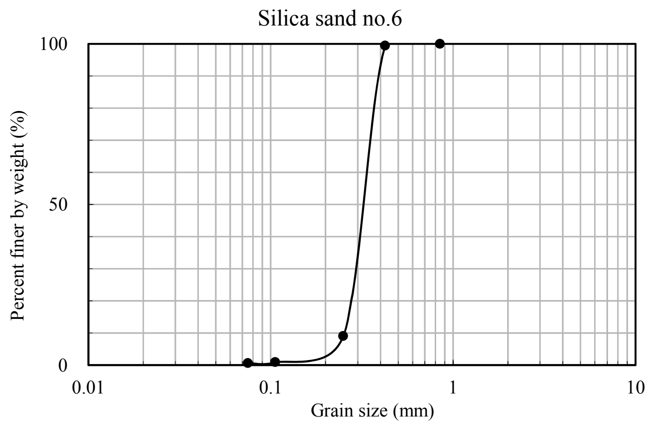


Figure 1 Particle size distribution curve

(2) The minimum and maximum dry density of the same silica sand No. 6 are ρ_{min} = 1.241 g/cm^3 and ρ_{max} = 1.556 g/cm^3, respectively. Using the soil particle density ρ_s =

2.643 g/cm^3 and the water density ρ_w = 1.000 g/cm^3, answer the sub-questions below:

(a) The void ratio in the loosest state at which the minimum dry density is obtained is defined as the maximum void ratio $e_{\max}$ while the void ratio in the densest state at which the maximum dry density is obtained is defined as the minimum void ratio $e_{\min}$. Determine $e_{\max}$ and $e_{\min}$.

(b) This sand is compacted under water content w = 10% to achieve a relative density D_r = 35%. Calculate the total density ρ_t under these conditions. Herein, D_r is defined by the following expression.

$$D_r = \frac{e_{max} - e}{e_{max} - e_{min}}$$

(c) In regard to (b), determine the degree of saturation S_r after the compaction.

(d) For the silica sand no.6 that was compacted under water content w = 10%, obtain the dry density ρ_{dsat} on the zero-air-void curve that is defined as the state of full water saturation (S_r = 100%) when pore air in the voids is completely expelled.

(3) Describe the meaning of liquid limit w_L, plastic limit w_P and plasticity index I_P. In addition, explain which aspects of soil properties are understood by knowing these values.

[Question 2] Answer the following questions related to the permeability of soils.

1) Briefly explain the terms given below. Schematic diagrams can be used to aid in your explanations.

(a) Constant head permeability test

(b) Quick sand

2) The soil specimen shown in Figure 2 was prepared by setting impermeable boundaries along both left and right sides of a partitioned block consisting of 2 layers of soil arranged in series and 1 layer of soil connected in parallel. The individual layers in series on the left-hand side have a width L_1 and a thickness H_1 and H_2 respectively, with individual coefficients of permeability k_1 and k_2. The single layer on the right-hand side has a width L_2 with thickness $H_1 + H_2$, and its coefficient of permeability is assumed to be k_3. By considering this a steady-state permeability problem where the water flows uniformly in the soil specimen along

the vertical direction, find the equivalent coefficient of permeability k_v for this soil specimen consisting of three different layers of soil.

3) Assume that $H_1 = L_1 = 30$ cm, $H_2 = L_2 = 20$ cm, $k_1 = 2.0\times10^{-2}$ cm/s, $k_2 = 5.0\times10^{-4}$ cm/s, $k_3 = 1.0\times10^{-3}$ cm/s. When a difference in total head h = 40 cm is applied between the top and the bottom of the specimen, calculate the total volume of water in a unit width (perpendicular to the figure) of 1 cm flowing through the specimen in an hour.

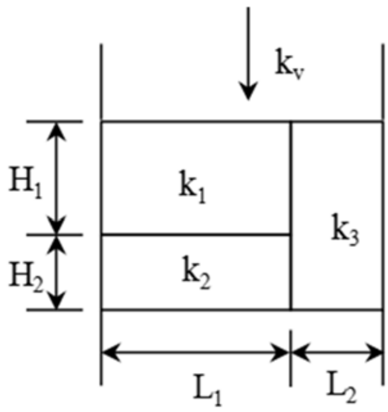


Figure 2