Mid Fall Term Exam for IPSE of CSE, 2013				20th, Nov., Wednesday	From: 18:15, To:19:45
Subject	Instructor	Department, Year		Answer / Separate / Reference	Reference tools are not allowed without admission.
Soil Mechanics	H. Akagi	Civil & Env.	2		1. Nothing 2. Free 3. Partly allowed ・~~Textbook~~・~~Reference book~~ ・Calculator ・~~Dictionary~~ ・~~Others~~〔 〕

Student ID		Name		Mark	

Answer all questions (1)～(5) on the separate answer sheet. The density of water is ρ_w=1.00(g/cm^3) and the water unit weight is γ_w=9.81(kN/m^3).

(1) A 1.50 (kg) of dry soil is poured into a Eureka can and displaces 600 (cm^3) of water (see Fig. 1). **Find the density of soil particles ρ_s (g/cm^3).**

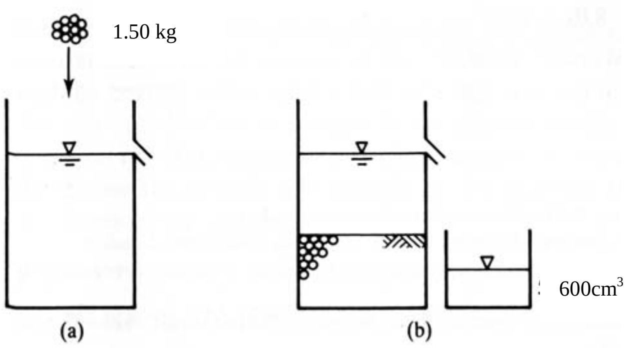


Fig.1

A 160 (g) of the same dry soil is poured uniformly into an empty impermeable metal container and occupied 180 (cm^3) (see Fig.2). The area of the inside cross section of the container is A=30.0 (cm^2). **Find the void ratio *e* of the dry soil in the container.**

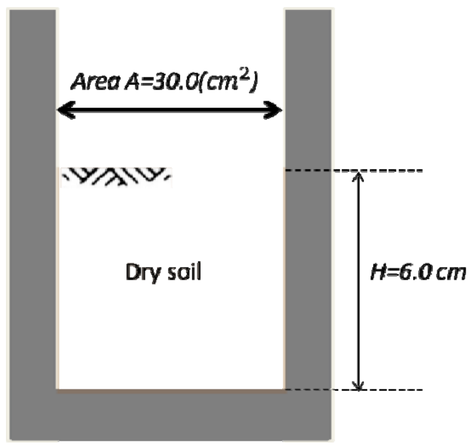


Fig.2

(2) Table 1 shows the results of the density test and water contents test of soil.
Find the density of soil particle ρ_s(g/cm^3), wet density of soil ρ_t(g/cm^3), water content w(%), dry density of soil ρ_d(g/cm^3), void ratio *e* and saturation ratio S_r(%).

Table 1

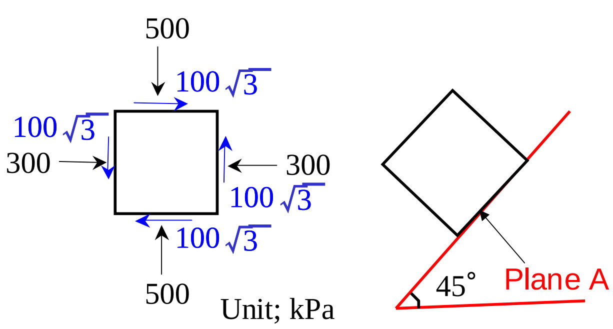
Types of test	Results	
Density of grains	Volume of the soil particle	11.00 cm^3
Water content	Mass of the wet specimen and container	92.50 g
Wet density	Mass of the specimen and container after drying at 105°C	78.90 g
	Mass of the container	49.30 g
	Volume of the wet specimen	26.20 cm^3

(3) Fig. 2 shows the state of stresses in an element of soil. (Positive shear stress and angles indicate counterclockwise direction.)

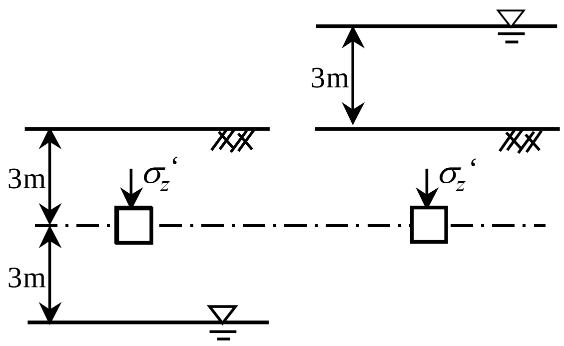
1) **Calculate the maximum and minimum principal stresses σ_1(kPa)and σ_3(kPa).**

2) **Calculate the angle α(degrees) formed by the plane of the maximum principal stress and the horizontal plane.**

3) The angle between plane A and horizontal plane within an element of soil is +45 degrees as shown in Fig. 2. **Calculate normal and shear stresses σ_A(kPa) and τ_A(kPa) acting on the plane A.**



Unit; kPa
Fig.2



(a) (b)
Fig.3

(4) The clay deposit in Fig.3 has unit weight γ_{sat}=20(kN/m^3) and the soil remains saturated if the pore pressures become negative.

1) When water table is 6 m below ground level as shown in Fig.3(a), **find the normal effective stress σ'$_{zA}$(kN/m^2) at a depth of 3m.**

2) When water table is 3 m above ground level as shown in Fig.3(b), **find the normal effective stress σ'$_{zB}$(kN/m^2) at a depth of 3m.**

(5) Fig.4 shows the one-dimensional water flow in the sand specimen. Datum line of potential water head *z* is at the central depth of the sand specimen.
Find the total water head h_a(m), h_b(m) and water flow volume Q(m^3/s).

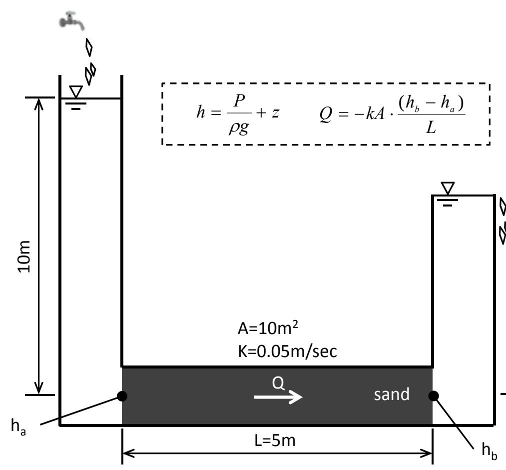


Fig.4

End of questions.

20th, November, 18：15〜19：45

International Program, Department of Civil and Environmental Engineering
Answer sheet for Mid Fall Term Exam, Soil Mechanics, 2013

Student ID ＿＿＿＿－＿＿＿＿ Name ＿＿＿＿＿＿＿＿ Mark ＿＿＿＿

Question No. (1)

$$\rho_s = \frac{1500(\mathrm{g})}{600(\mathrm{cm}^3)} = 2.5(\mathrm{g/cm}^3),$$

$$v_s = \frac{160(\mathrm{g})}{2.5(\mathrm{g/cm}^3)} = 64(\mathrm{cm}^3),\ v_v = 180 - 64 = 116(\mathrm{cm}^3),\ e = \frac{116}{64} \doteqdot 1.81$$

10×2=20

Question No. (2)

$$\rho_s = \frac{78.90 - 49.30}{11.00} \doteqdot 2.69(\mathrm{g/cm}^3), \quad \rho_t = \frac{92.50 - 49.30}{26.20} = 1.65(\mathrm{g/cm}^3),$$

$$w = \frac{92.50 - 78.90}{78.90 - 49.30} \times 100 \doteqdot 45.9(\%), \quad \rho_d = \frac{78.90 - 49.30}{26.20} \doteqdot 1.138(\mathrm{g/cm}^3),$$

$$e = \frac{26.20 - 11.00}{11.00} = 1.38, \quad Sr = \frac{92.50 - 78.90}{26.20 - 11.00} \times 100 = 89.5(\%)$$

3×6+2=20

Question No. (3)

$$(1)\sigma_1 = 600(\mathrm{kPa}), \sigma_3 = 200(\mathrm{kPa}),$$

$$(2)2\alpha = +60^\circ \quad \alpha = +30^\circ \ ,$$

$$(3)\sigma_A = 400 + 100\sqrt{3}(\mathrm{kPa}),$$

$$\tau_A = 100(\mathrm{kPa})$$

4×5=20

Question No. (4)

$$(1)\sigma_{zA} = 20.0 \times 3 = 60(\mathrm{kN/m^2}), \quad u_A = -29.4(\mathrm{kN/m^2}), \sigma'_{zA} = 60 - (-29.4) = 89.4(\mathrm{kN/m^2}),$$

$$(2)\sigma_{zB} = 9.81 \times 3 + 20.0 \times 3 = 89.4(\mathrm{kN/m^2}), u_B = 9.81 \times 6 = 58.9(\mathrm{kN/m^2}),$$

$$\sigma'_{zB} = 89.4 - 58.9 = 30.5(\mathrm{kN/m^2}),$$

10×2=20

Question No. (5)

$$h_a = 0 + 10(\mathrm{m}) = 10(\mathrm{m}), h_b = 5(\mathrm{m}),$$

$$Q = 0.05(\tfrac{\mathrm{m}}{s}) \times 10(\mathrm{m}^2) \times \frac{10-5}{5} = 0.5(\mathrm{m}^3/\mathrm{s})$$

3×6+2=20