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B. Sc. Engg. (CEE)/4th Sem. May 21, 2024 (Group B)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination **Summer Semester: 2022-2023**
Course No.: CEE 4441 **Full Marks: 200**
Course Title: Soil Mechanics **Time: 3 Hours**

There are 7 (Seven) questions. Answer 6 Questions. Answer one question from questions 1 and 2. Questions 3 to 7 are compulsory. Programmable calculators are not allowed. The figures in the right margin indicate full marks. The Symbols have their usual meaning.

1 (a) Briefly explain soil fabric and structure. (10) (CO1) (PO1)

(b) Briefly demonstrate the Casagrande method for determination of the Liquid Limit. (6) (CO1) (PO1)

(c) The mass of a soil specimen is 800 g. After oven-dried, the mass becomes 680 g. Determine the total volume and void ratio of the sample where the specific gravity of the soil is 2.65, and the degree of saturation is 50%. (9) (CO1) (PO1)

(d) Define the optimum water content. What do you mean by the dry of optimum and wet of optimum. (5) (CO1) (PO1)

2(a). Derive the equation of the degree of consolidation in one-dimensional condition proposed by Terzaghi. Also, write down the assumptions applied in deriving the equation. (15) (CO1) (PO1)

2(b). A plan of a uniformly loaded rectangular area, having a load of 200 kPa, is shown in **Fig.1**. Determine vertical stress increases below point **A** at depths of 0.3m and 5.0m. Use, **Fig. A** for getting I_3. (15) (CO1) (PO1)

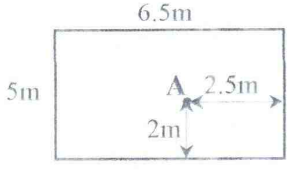

Fig.1

3(a). To construct a road, 10,000m^3 compacted soil is required, where the void ratio of the compacted soil is specified as 0.62. Three borrow pits are available near the project. Table 1 lists the respective void ratios of the soil and the cost per cubic meter of the soil. Make necessary calculations to select a pit from which the soil should be bought to minimize the cost. Assume G_s=2.70 for all pits. Use, γ_w= 9.81 kN/m^3. (18) (CO3) (PO3)

Table 1. void ratio and cost of different pits

Pit	void ratio	Cost (USD)/m^3
A	1.30	5.00
B	0.90	6.00
C	1.20	5.20

3(b). An earth dam of volume 20,000m^3 will be constructed using soil either from pit **A** or pit **B**. Soil parameters of pit **A**, G_s=2.65, e=0.90, w=20%, w_{opt}=15%; and at pit **B**, G_s=2.70, e=0.85, w=12%, w_{opt}=16%. At both sites $\gamma_{d(max)}$=18.50 kN/m^3. The dam must be constructed for γ_d=18.50 kN/m^3. Answer the following questions- (15) (CO3) (PO3)

(i) For constructing the dam, which pit is suitable?
(ii) What will be the required volume of the soil? Use, suitable pit only.
(iii) How much water needs to be added to maintain the required dry density of the dam?

4(a). The time required for 50% consolidation of a 25mm thick clay layer (drained at both top and bottom) in the laboratory is 5 min. How long (in days) will it take for a 5.0m thick clay layer of the same clay in the field under the same pressure increment to reach 50% consolidation? In the field, there is a sand layer underneath the clay layer. Use, T_v=0.197 for 50% consolidation. (10) (CO2) (PO2)

4(b). Answer the following questions for a clay layer shown in **Fig.2**, γ_{sat}=17.81 kN/m^3, γ_w= 9.81 kN/m^3, C_c=0.35, C_s = 0.05, e_0 = 0.90 at the center of the layer, C_v = 5.0 m^2/year. (25) (CO2) (PO2)

(i) Compute settlement of the clay layer for 90% primary consolidation using σ'_c = 100 kN/m^2.

(ii) If σ'_c = 150 kN/m^2, what will be the total primary consolidation settlement of the clay layer?

(iii) Compute the time required to reach 100% primary consolidation where the time factor, T_v=1.781 for 100% consolidation.

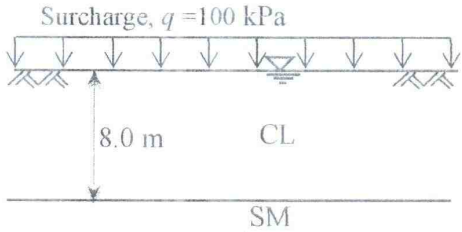

Fig.2.

5. A concrete Dam is shown in **Fig.3**. Answer the following questions – (35)

(i) Draw flow-nets for the ground. (CO2) (PO2)

(ii) Calculate the seepage per day under the concrete dam, where the coefficient of permeability of the soil, $k = 1.0\times10^{-4}$ m/sec.

(iii) Compute total head, pressure head, and elevation head at points A, B, C, and D.

(iv) Check the condition of piping for saturated unit weight of soil, γ_{sat}=18.81 kN/m^3, use γ_w= 9.81 kN/m^3.

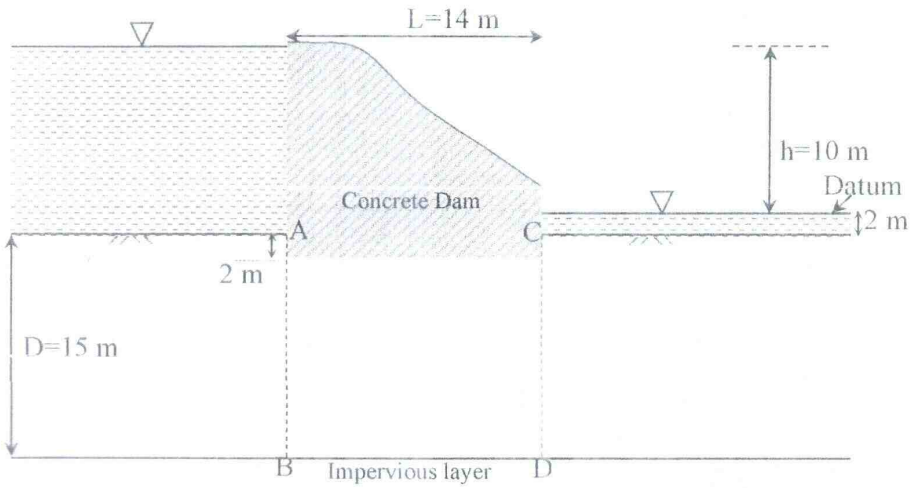

Fig.3

6(a). Compute normal stress at point **A** on a tunnel liner shown in **Fig.4**, considering earth pressure at rest. (15) (CO3) (PO3)

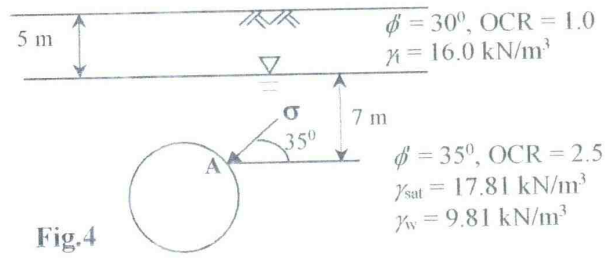

Fig.4

6(b). You are planned to excavate ground having clayey soil to build a foundation. The undrained shear strength of the soil is 32 kPa, unit weight of the soil is 16 kN/m^3. Compute the maximum depth you can excavate without any retaining structure. Consider the undrained condition of the ground. (6) (CO3) (PO3)

6(c). A building will be constructed with two basement floors in the ground shown in **Fig.5**. Ground will be excavated after inserting retaining structure in the ground. The ground water table is at the top of the ground. Answer the following questions - (12) (CO3) (PO3)

(i) Compute the angle of internal friction of the soil.

(ii) Compute the required embedded depth, z_p, of the retaining structure considering equilibrium between active and passive earth pressures.

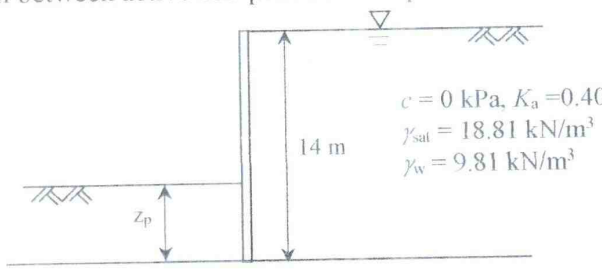

Fig.5

7. **Fig.6** shows a frictionless retaining wall in active earth pressure conditions. Answer the following questions – (34) (CO3) (PO3)

(i) Draw the distributions of total vertical stress, effective vertical stress, pore water pressure, and effective lateral stress considering the Rankine active earth pressure. Use $\gamma_w = 9.81$ kN/m^3.

(ii) Compute total active earth pressure acting on the retaining wall.

(iii) Compute the location of the resultant active earth pressure acting on the retaining wall.

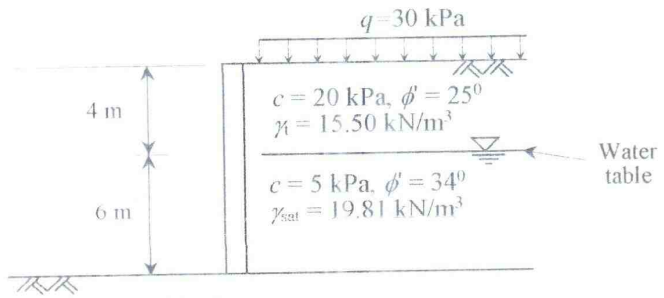

Fig.6

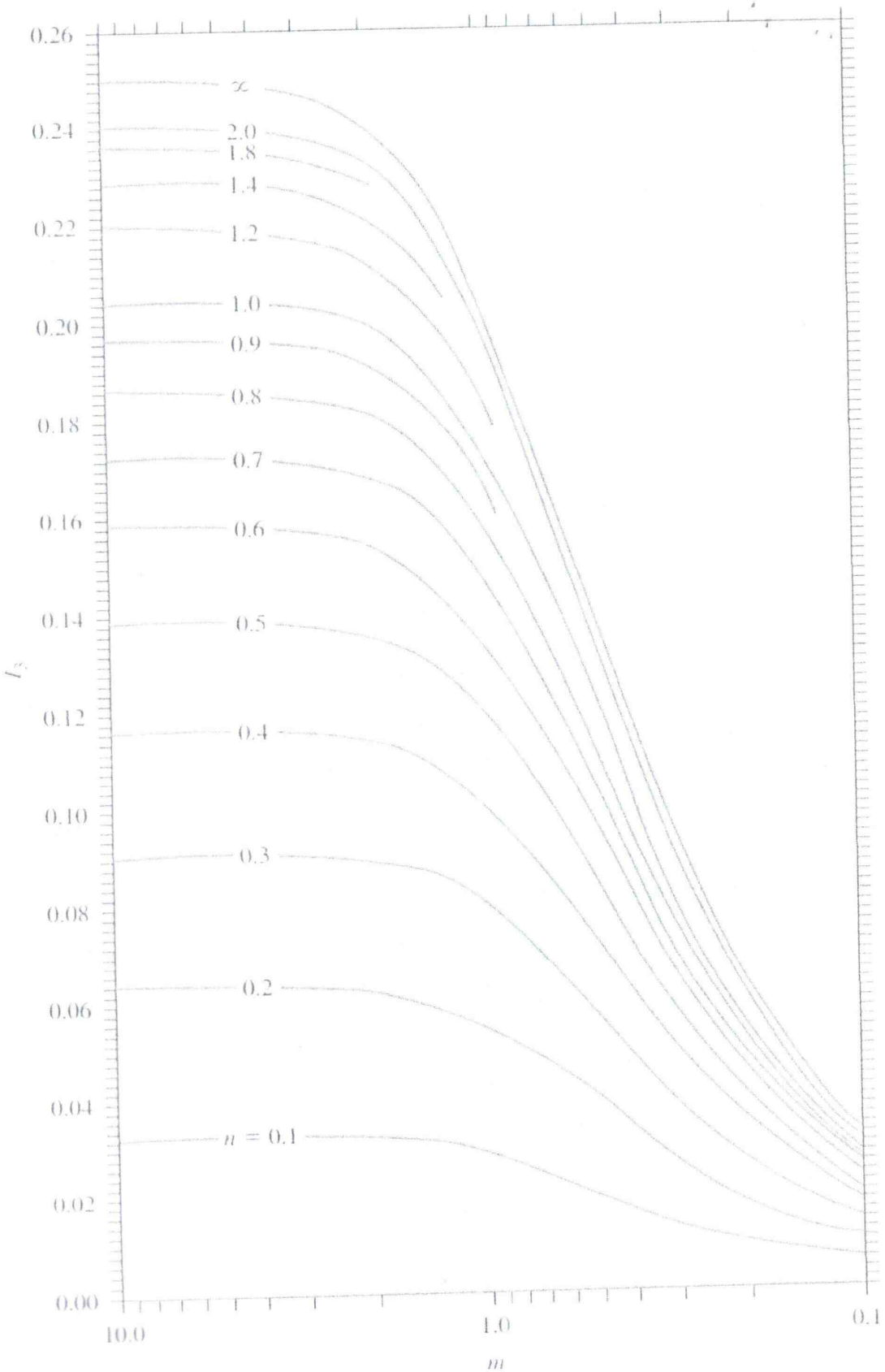

Fig. A Variation of I_3 with m and n