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B. Sc. Engg. (CEE)/ 4th Sem. 04 May 2023 (Group B)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Semester Final Examination — **Summer Semester: 2021-2022**
Course No.: CEE 4441 — **Full Marks: 200**
Course Title: Soil Mechanics — **Time: 3.0 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 describe – (i) Liquidity index, (ii) Single grain fabric, (iii) Honeycomb fabric, (iv) Mechanical properties of soil, and (v) Activity of soil. (15) (CO1) (PO1)

1(b). Explain earth pressure at rest, active earth pressure, and passive earth pressure. (9) (CO1) (PO1)

1(c). Briefly explain a method of ground treatment for a soft clayey layer to accelerate consolidation settlement. (5) (CO1) (PO1)

2(a). For soil, moisture content, $w = 16\%$, $G_s = 2.72$, The density of the soil is 1850 kg/m^3. Use, $\rho_w = 1000$ kg/m^3. Regarding the soil, determine: (14) (CO1) (PO1)
(i) Dry density,
(ii) Void ratio,
(iii) Degree of saturation, and
(iv) Mass of water is required to add to reach full saturation of 1.0 m^3 soil.

2(b). An embankment is shown in Fig.1, determine the stress increase under the embankment at point A. Unit weight of the embankment soil, $\gamma = 18.0$ kN/m^3. Use Fig.8 for getting I_2. (15) (CO1) (PO1)

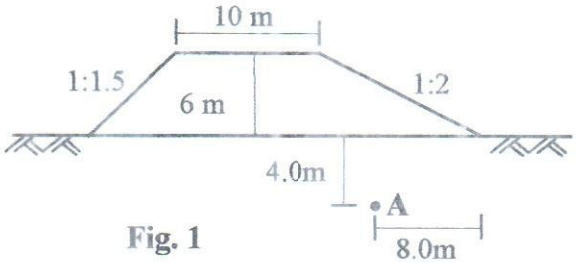

Fig. 1

3. Answer the following questions for a clay layer shown in Fig.2, $\gamma_{sat} = 18.81$ kN/m^3, $\gamma_w = 9.81$ kN/m^3, $C_c = 0.25$, $C_s = 0.04$, $e_0 = 0.80$ at the center of the layer, $C_v = 2.0$ m^2/year, and $c_\alpha = 0.008$. Preconsolidation pressure of the clayey layer is 80 kN/m^2. (34) (CO2) (PO2)
(i) Compute the total primary consolidation settlement of the clay layer.
(ii) Compute the time required to reach the 100% primary consolidation where the time factor, $T_v = 1.781$.
(iii) Calculate the total consolidation (primary and secondary) settlement after 40 years of applying the surcharge.

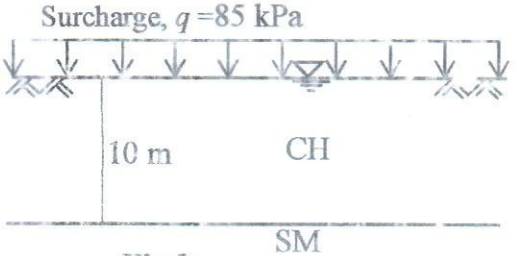

Fig.2

4(a). Derive the expression of passive earth pressure by Mohr-Coulomb failure criteria. (15) (CO1) (PO1)

4(b). Answer the following questions for the concrete dam shown in Fig.3. (18) (CO2) (PO2)

(i) Calculate the coefficient of permeabilities in the horizontal and vertical directions.

(ii) The dimensions of the dam are - the top width is 10 m, the bottom width is 30 m, and the height is 18 m. What will be the dimensions of the dam for constructing flow-nets? Show the procedure from the flow equation for homogeneous soil,

$$k_H \frac{\partial^2 h}{\partial x^2} + k_V \frac{\partial^2 h}{\partial z^2} = 0.$$

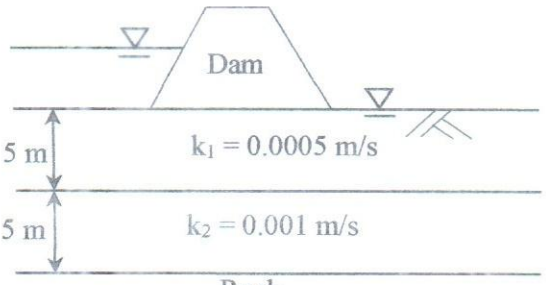

Fig.3

5. Answer the following questions related to Fig.4. (36) (CO2) (PO2)

(i) Draw flow-nets of the ground.

(ii) Estimate the seepage per day under the retaining wall. Here, the coefficient of permeability of the soil, k=1.0×10^{-4} m/s.

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

(iv) If the saturated unit weight of soil, γ_{sat}=16.81 kN/m^3, check the condition of piping. Use, γ_w=9.81 kN/m^3.

(v) If piping occurs, describe briefly how you will mitigate the piping.

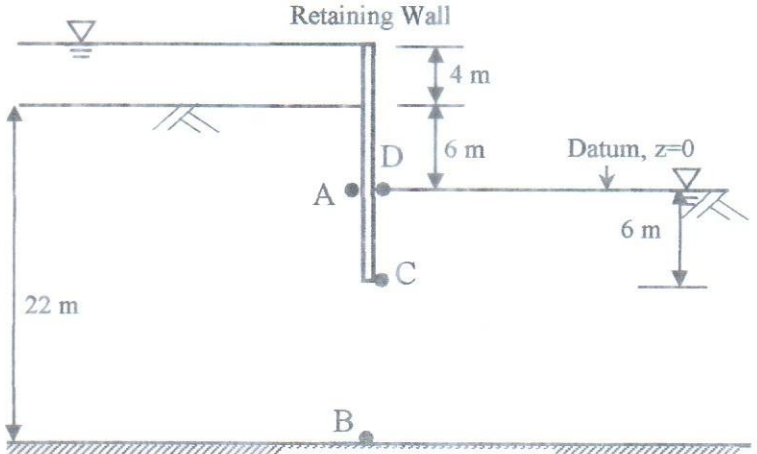

Fig. 4

6(a). A bridge connecting approach road having a length of 10.0 km will be constructed in Patuakhali, Fig.5 shows a typical cross-section of the road. The void ratio of the compacted fill is specified as 0.65. Three borrow pits are available, as described in Table 1, which lists the respective void ratios of the soil and the cost per cubic meter of the soil to the proposed construction site with transportation cost. Make necessary calculations to select a pit from which the soil should be brought considering economic point of view. Assume G_s=2.68 for all pits, and use γ_w= 9.81 kN/m^3. (18) (CO3) (PO3)

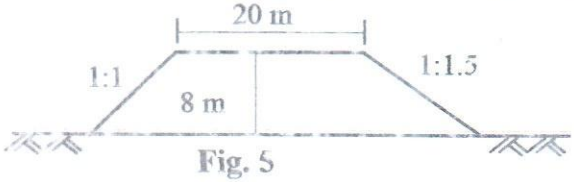

Fig. 5

Table 1. void ratio and cost of different pits

Pit	void ratio	Cost (USD)/m^3
A	0.85	5.20
B	0.72	5.50
C	0.83	5.35

6(b). Calculate lateral total stress at Point A shown in Fig.6. Use Jaky's equation for the coefficient of earth pressure at rest. (6) (CO3) (PO3)

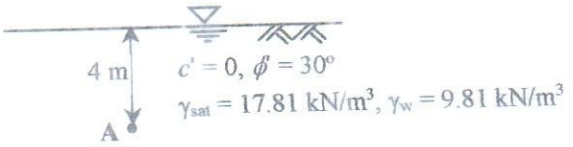

Fig. 6

6(c). Calculate the depths of tensile crack while excavating ground considering (i) without traffic load, and (ii) with traffic load. The parameters of the ground are - $c' = 20$ kPa, $\phi' = 15^0$, $\gamma_t = 16$ kN/m^3. The traffic load on the ground is 20 kN/m^2. Water table is far below the excavation. (8) (CO3) (PO3)

7. Answer the following questions for the retaining wall shown in Fig.7. Consider there is no friction between the wall and the soil. Use, γ_w=9.81 kN/m^3. (36) (CO3) (PO3)
   (i) Draw the distributions of effective vertical stress, pore water pressure, and active lateral effective stress.
   (ii) Compute Rankine active earth pressure.
   (iii) Determine the location of the resultant line of action of P_a.
   (iv) Explain why retaining wall is designed with the total stress not with the effective stress only.

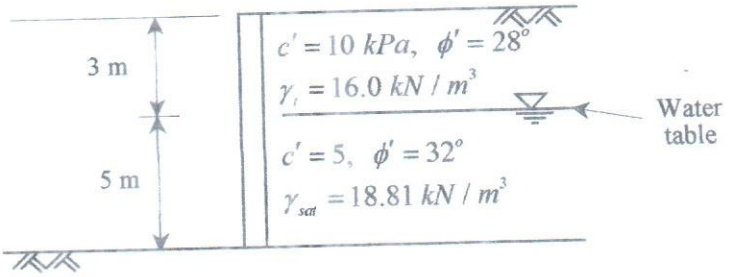

Fig. 7

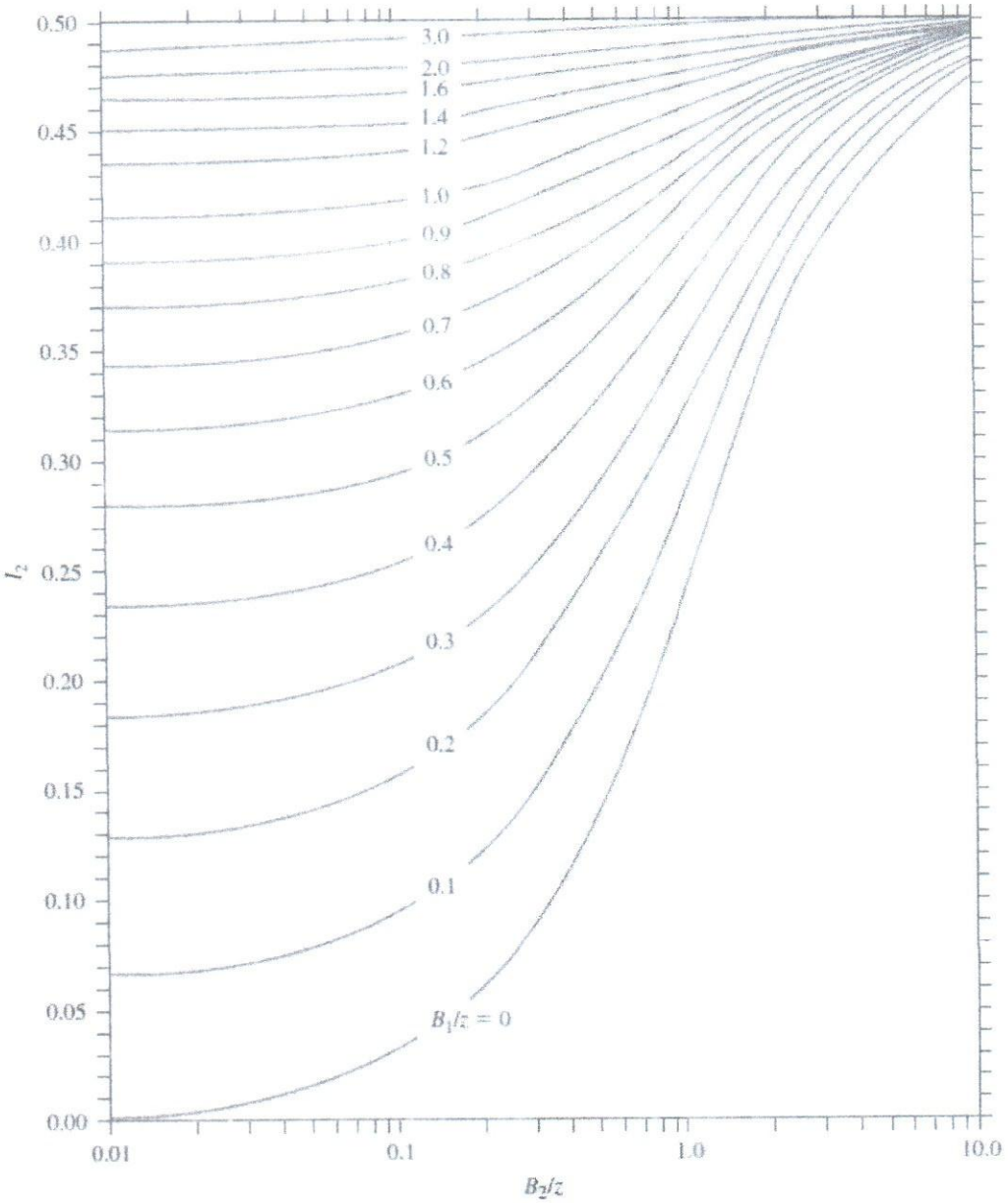

Fig. 8 Osterberg's chart for determination of vertical stress due to embankment loading