B. Sc. Engg. (CEE)/ 5th Sem. 10 October, 2023 (Afternoon)

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)

ORGANISATION OF ISLAMIC COOPERATION (OIC)

DEPARTMENT OF CIVIL AND ENVIRONMENTAL ENGINEERING

Mid Semester Examination **Winter Semester: 2022-2023**
Course No.: CEE 4543 **Full Marks: 75**
Course Title: Foundation Engineering **Time: 1.5 Hours**

There are 4 (Four) questions. Answer 3 (Three) questions. Question 1 is compulsory. Answer 2 questions from questions 2, 3, and 4. Programmable calculators are not allowed. The figures in the right margin indicate full marks.

1(a). Briefly explain the procedure of the Standard Penetration Test. (5) (CO1) (PO1)

1(b). Derive the equation of virtual work per unit length ($W_D = c.v_{rs}$) in a discontinuous surface using Mohr–Coulomb failure criteria for c-ϕ soil. (10) (CO1) (PO1)

1(c). Briefly explain a pile load test with a neat sketch of a schematic diagram of the test arrangement. Also, plot a typical load settlement curve for a pile load test. (6) (CO1) (PO1)

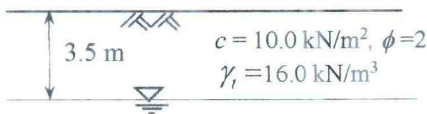
2. A footing of 2.9 m X 3.3 m is placed at a depth of 2.1 m from the ground surface. The vertical load of 2.2 MN, bending moments about the shorter direction of 480 kN-m, and bending moment about the longer direction of 360 kN-m are acting on the footing. The ground conditions are shown in **Fig.1**. (27) (CO2) (PO3)

Answer the following:

(i) Estimate the ultimate bearing capacity of the footing. Use Meyerhof equations for bearing capacity factors, shape factors, and depth factors.

(ii) Estimate the effective allowable load capacity of the footing using both Meyerhof and the Bowles equation for eccentricity. Use a factor of safety of 2.5.

(iii) Calculate the maximum and minimum stresses acting on the soil for the design load and check with the strength of the soil, where the strength of the soil is 300 kPa.



$c = 5.0$ kN/m², $\phi = 31°$
$\gamma_{sat} = 18.81$ kN/m³
$\gamma_w = 9.81$ kN/m³

Fig.1

3(a). Compute the dimensions of a rectangular combined footing (B and L) for supporting two columns (in column 1, Q_1= 7.0 MN, in column 2, Q_2=5.0 MN) placed at a distance of 4.5 m. The second column is located 1.2 m from the property line. The net allowable bearing capacity of the ground is 250 kPa. (6) (CO2) (PO3)

3(b). Compute the dimensions of a trapezoidal combined footing (B_1, B_2, and L) for the conditions mentioned in question 3(a). Use $B_1 = 1.20\ B_2$. (8) (CO2) (PO3)

3(c). Size of a pile is 350 mm × 350 mm having a length of 18 m, and the top of the pile is at ground level. The soil layers are as follows- (13) (CO2) (PO3)

Soil Layers:

0 – 4 m, sand, unit weight = 17.5 kN/m^3, soil friction angle = 28^0, $\delta = 19^0$, K= 0.90, and

4 – 25 m, sand, unit weight = 18.81 kN/m^3, soil friction angle = 34^0, $\delta = 24^0$, K= 1.4, N_q=125.

Use, critical Depth $(L/D)_{cr}$ = 15D

Estimate the ultimate axial load capacity of the pile considering water table is at 3m below the ground level. Use, γ_w =9.81 kN/m^3.

4(a). Size of a pile is 16 inch × 16 inch having a length of 60 feet, and the top of the pile is at ground level. The soil layers are as follows- (15) (CO2) (PO3)

Soil Layers:

0 – 30 ft, normally consolidated clay, unit weight = 105 pcf,
Unconfined compression strength = 0.80 ksf, reduction factor = 0.90

30 – 120 ft, clay, unit weight = 125 pcf,
Unconfined compression strength = 2.0 ksf, reduction factor = 0.80

Below 120 ft a thick deposit of dense sand exits.

Estimate the axial compression capacity of the pile considering water table is at 20 ft below the ground level. Use, N_c = 9, and γ_w=62.4 pcf. Draw a neat sketch showing the stated condition.

4(b). Calculate the axial compression capacity of a 30 inch diameter and 50 feet length (top at ground level) **drilled shaft**. The ground condition is shown in **Fig.2** which consists of sandy soil. (12) (CO2) (PO3)

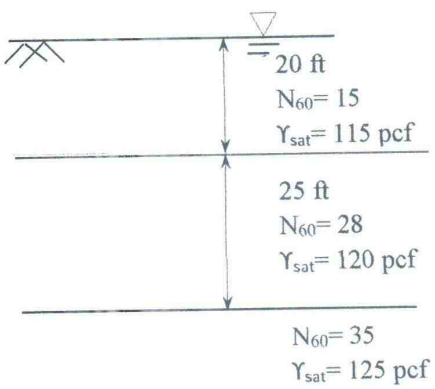


Fig.2