Ref. No. : Ex/PG/CE/T/111C/2024

M.E. CIVIL ENGINEERING FIRST YEAR FIRST SEMESTER - 2024
SUBJECT: ADVANCED FOUNDATION ENGINEERING (SMFE)
Time: 3 HOURS Full Marks : 100
Assume reasonable values of data not supplied

USE ALL RELEVANT IS CODES RELATED TO DESIGN OF FOUNDATIONS

1. Design a shallow foundation (isolated – square) for a column load of magnitude 500 kN resting at a depth of 1.0m below existing ground level. Soil stratification at the site is given below.
Stratum I: Soft / firm brownish grey silty clay / clayey silt of thickness 3.0m with undrained cohesion Cu = 40kPa, γ_{sat}=18.8kN/m^3, Cc'/1+e0 = 0.03, p_c= 70 kN/m^2, Cc/1+e0 = 0.13.
Stratum II: Soft dark grey / grey silty clay / clayey silt with decomposed wood of thickness 15.0m with undrained cohesion Cu = 20kPa, γ_{sat}=16.5kN/m^3, Cc/1+e0 = 0.15.
Stratum III: Medium / stiff bluish grey / mottled brown silty clay / clayey silt with undrained cohesion Cu = 60kPa, γ_{sat}=19kN/m^3, Cc/1+e0=0.09 down to 20.0m below ground level.
Stratum IV: A deep deposit of sand (below 20.0m) of angle of shearing resistance 34^0 and bulk density 19.5kN/m^3. GWT is at the ground level.

a. Write down the expression for ultimate bearing capacity for layered soil for the given condition.
b. Determine the bearing capacity considering layered soil and fix up the size of the foundation.
c. Determine the settlement of the foundation and apply all corrections to obtain corrected settlement of the foundation.
d. If the corrected settlement more than the permissible value, modify the design.

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2. Design a raft foundation of size 15m x 25m carrying superstructure load of 4500 ton. Subsoil stratification at the site is same as that given in Question 1.
a. Determine the proposed depth of foundation considering buoyancy raft if conventional raft is found not suitable.
b. Determine the settlement of foundation and check whether it is within permissible value, if not modify the design. 20

3(a) A pile group is to be constructed to support design column load (vertical) of 2500kN. Subsoil at the site consists of top soft clay of thickness 12m (undrained cohesion Cu = 20kPa, α=1.0, ϕ'= 24^0, γ_{sat}=17kN/m^3, Cc/1+e0 = 0.15) followed by a layer of medium / stiff clay (undrained cohesion Cu = 70kPa, α=0.64, ϕ'= 25^0, γ_{sat}=19kN/m^3, Cc/1+e0=0.07) down to 20.0m below ground level. This is underlain by a deep deposit of sand with angle of shearing resistance (ϕ') 34^0 and bulk density (γ_{sat}) 19.5kN/m^3. GWT is at the ground level.

Take length of pile = 24m and cut-off level at 2.0m below the ground level. Determine the safe vertical capacity of single pile using α Method with a factor of safety of 2.5. Design the pile group and also determine the settlement of the pile group under superimposed vertical load.

(b) Write a short note on negative skin friction. 20+5=25

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4. A well foundation of diameter 8m is required to be provided for supporting a bridge pier at a site with stratification given below :

From River bed to 8.0m : Loose / medium silty sand : Angle of shearing resistance 32^0 and bulk density 18.5kN/m^3, N value = 20-25 blows/ 30cm
From 8.0m to 20.0m : Medium / dense silty sand : Angle of shearing resistance 34^0 and bulk density 19.5kN/m^3, N value = 25-35 blows/ 30cm
From 20.0m to 50.0m : Dense / very dense silty sand : Angle of shearing resistance 36^0 and bulk density 19.5kN/m^3, N value = 45 - 60 blows/ 30cm

Data given : maximum flood discharge = 10465 cumec; width of waterway = 382m; HFL = 8m above river bed; silt factor = 1.053.

a. Compute the maximum scour depth and determine the founding level of the well.
b. Estimate the net allowable bearing capacity of the well

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5. Draw a neat sketch of an under-reamed pile giving typical dimensions. Also give the expression for ultimate bearing capacity. Further discuss the situations in which this type of pile is adopted in practice. 8

5. A concrete block of size 8m x 4m x 2m is to be used as a foundation of a reciprocating machine operating at 500 rpm. The machine is mounted symmetrically with respect to the foundation. The weight of the machine is 10kN. The operation of the machine exerts an unbalanced vertical force of magnitude 1.7 sin ωt kN.
The values of the dynamic elastic constants for the design of the foundation may be adopted as below:
Coefficient of elastic uniform compression = 4.6 x10^4 kN/m^3 ; G = 4.8 x 10^4 kN/m^2;
bulk density of soil = 18 kN/m^3; bulk density of concrete = 24 kN/m^3

Determine the natural frequency and amplitude of the block. 12