M.E. (Civil) 1st Semester Examination, December 2011

Foundation Engineering - I (CE - 909)

Full Marks: 100 Time: 3 Hours

Answer any **Four** questions
Assume reasonable value for any data not supplied
The following IS Codes are allowed during the examination:
(i) IS: 6403 (ii) IS: 8009 (iii) IS 456 (iii) SP: 16

1. (a) State and explain Skempton's equation of net ultimate bearing capacity. Also state the condition of applicability of the equation.

(b) How can you determine the bearing capacity of a shallow footing from the results of SPT test?

(b) A square footing of width 2.2 m is constructed at 1.2 m below GL in a homogeneous bed of dry sand (γ = 16.9 kN/m^3, γ_{sat} = 16.9 kN/m^3, $\phi = \phi' = 36°$). The water table is at 0.8 m below the ground level. Determine the maximum load the footing can carry with respect to a factor of safety of 3 against shear failure. Use Terzaghi's equation. Given, for $\phi = 36°$, N_c = 65.4, N_q = 49.4 and N_γ = 54.0. [7+3+15=25]

2. (a) 'The settlement of a shallow footing on sand should be estimated from the results of field tests and not from the laboratory test results.' – Justify the statement.

(b) While designing a square footing to support a column of a building, it was found that the width of the footing must be restricted to 1.75 due to space constraints. The gross load on the column is computed as 1500 kN. The subsoil has the following properties:

γ = 18.5 kN/m^3, c = 0, $\phi = 36°$

Determine the required minimum depth of foundation of the footing if a factor of safety of 3 is desired with respect to shear failure of the soil. [5+20=25]

3. A square footing of 2.5 m width is to be founded at 1.2 m below GL in a deep deposit of normally consolidated clay having the following properties:

G = 2.72; w = 33%, L.L. = 45%, q_u = 68 kPa

The water table is at the G.L. Compute (i) the safe bearing capacity and (ii) the allowable bearing pressure of the footing. Adopt a factor of safety of 3. The depth correction factor and the oedometer correction factor, with respect to the estimated settlement, may be taken as 0.85 and 0.80 respectively. [25]

4. A column of 250 mm x 400 mm has to carry a gross load of 450 kN. The subsoil consists of a deep deposit of clay for which the net allowable bearing pressure may be taken as 50 kN/m^2.

(a) Design a suitable concentric square footing to support the column.

(b) Determine the minimum depth of the footing slab required if M_{20} concrete and Fe_{415} steel are used in the construction. [8+17]

5. Two identical columns of a building each having a cross-section of 250 mm x 250 mm, are spaced at a centre-to-centre distance of 4.0 m from each other. The gross loads on the columns (inclusive of self-weight) are 450 and 700 kN. The columns are to be supported by a combined footing with a central beam. Due to space restrictions, the edge of the footing can not be projected beyond a distance of 0.5 m from the outer edge of the column carrying the greater load.

(a) Proportion a suitable trapezoidal footing for the columns. The net allowable bearing pressure may be taken as 50 kN/m^2.

(b) Draw the bending moment diagram for the central beam. [10+15]

6. It is required to construct a strap footing to support two adjacent columns of a building. The centre-to-centre distance between the columns is 5.5 m and each column has a cross-section of 250 mm x 400 mm. The columns are placed with their longer faces parallel to one another, while their respective shorter faces lie on the same lines. The gross loads on the columns are 650 kN and 850 kN. The footing cannot be projected beyond a distance of 0.5 m from the center of the column carrying the smaller load. The net allowable bearing pressure may be taken as 60 kN/m^2. Proportion a suitable strap footing to support the columns. Draw the sectional elevation and plan of the strap footing and show all relevant dimensions. [25]