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Only Formulae Sheet, tables, charts, graphs are Allowed.

**Q1.** Discuss need and necessity of Pile load test. What are the recommendations of IS2911 for need and necessity of pile load test? And why? What is role of structural engineer related to pile load test, explain briefly. [2 Marks]

**Q2.** What are the criterion given in IS 4998 : 2015 for rigid foundation analysis of chimney foundations? [2 Marks]

**Q3.** Find rotation of square footing (2 m x 2 m) subjected to a moment of 100 kN-m and vertical load = 150 kN at the center of footing. The soil parameters are  $E_s = 12 \text{ MPa}$ ,  $\nu = 0.40$ . Find rotation of footing using ACI 351.3R-2018 formulations. Check safety for permissible rotation of  $0.1^\circ$ , if unsafe find safe size. [ 3 Marks]

**Q4.** A 2.5 m x 2.5 m square isolated footing is 400 mm thick reinforced concrete (M25) slab. Find relative stiffens factor K and check whether it will act as a rigid footing in a soil with  $E_s = 15000 \text{ kPa}$  as per IS2950. [ 2 Marks]

**Q.5** A Ring footing of water tank with outer diameter 20 m and inner diameter 12 m is subjected to a direct compressive load of 30 MN and a moment of 150 MN-m. Moment is due to earthquake load. Is foundation safe, apply all checks? Draw the pressure distribution of the footing. Assume allowable soil pressure for the soil [SPT,  $N = 32$ ] is 300 kPa. [ 3 marks]

**Q6.** For a highway bridge free head reinforced concrete (M40) pile 0.70 m diameter in section is driven into a medium dense sand to a depth of 20 m. The sand is in a submerged state with design modulus of subgrade reaction = 2.12 MPa/m. A lateral load of 200 kN and moment 100 kN-m is applied on the pile at ground level. (a) Compute the lateral deflection of the pile at ground level (b) Find maximum moment in pile and depth. Also find depth where moment will become zero. The submerged unit weight of the soil is  $8.75 \text{ kN/m}^3$  [5 marks]

**Q7.** Design and detail a precast driven reinforced concrete circular pile (diameter = 0.5 m, Length = 15 m) subjected to a factored compressive load of 950 kN and a factored moment of 110 kN-m. Use M25 mix concrete and Fe 415 grade steel. Assume  $d'/D = 0.15$ . Transverse reinforcement spacing less than 75 is not permitted. Use minimum possible size of longitudinal and lateral reinforcements. Assume other data suitably as per Indian Standard. Draw neat sketch showing all details. [5 marks]

**Q8.** Find the safe thickness of the isolated square footing by one-way shear (assume 0.25% steel), two-way shear and flexure for the column (size 500 mm x 500 mm) subjected to a factored axial force of  $V_u = 1000 \text{ kN}$  and factored moment of  $M_u = 200 \text{ kNm}$  due to earthquake. Assuming 3.0 m width of foundation is worked out safe and center of column coincide with the center of footing. Take M 30 grade concrete and 20 mm bars of Fe 500 grade steel for both footing and column. [5 marks]

**Q9.** A rectangular footing 2.5 x 4 m (designed for the column whose center coincides with the center of footing) is subjected to biaxial moments of  $M_y = 900 \text{ kN-m}$  (about an axis parallel to 2.5 m side and axis is passing through CG of footing) and  $M_x = 400 \text{ kN-m}$  (about an axis parallel to 4 m side and axis is passing through CG of footing) as well as vertical load of 1000 kN. Assess whether the footing is under tension or compression. Draw the properly dimensioned plan of the foundation (with suitable depiction of zero pressure line) and pressure distribution. [4 Marks]

**Paper Ends**