CSM – 18/21
Civil Engineering
Paper – I

Time : 3 hours

Full Marks : 300

The figures in the right-hand margin indicate marks.

*Candidates should attempt Q. No. 1 from Section – A and Q. No. 5 from Section – B which are compulsory and any **three** of the remaining questions, selecting at least **one** from each Section.*

SECTION – A

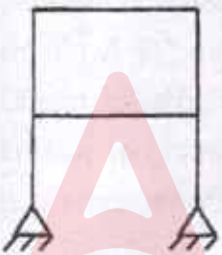
1. Answer any **three** questions of the following :

   (a) Design a singly reinforced concrete beam of clear span 4m to support a design working live load of 10kN/m. Adopt M20 grade concrete and Fe415HYSD bars. 20

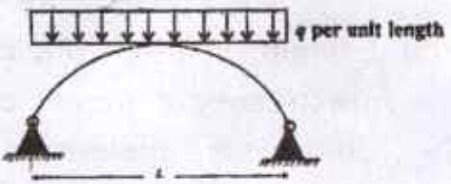
   (b) Explain, in brief, the advantages of prestressed concrete construction ? Differentiate pretensioning with post-tensioning in prestressed concrete 6. (a)

construction. Define bonded and non-bonded prestressed concrete. 4+8+8 = 20

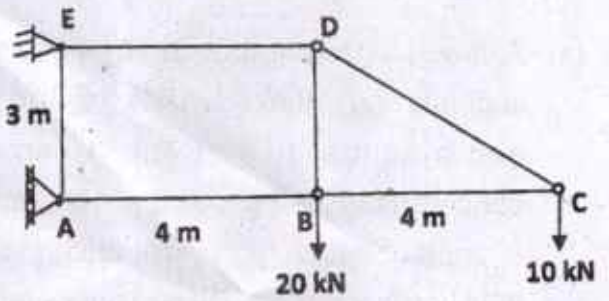
(c) (i) If the axial and shear deformation in different members of the frame below are assumed to be negligible, then determine the reduction in the degree of kinematic indeterminacy. 10



(ii) Determine the maximum bending moment in the two-hinged parabolic arch shown in figure. Draw the SFD and BMD. 10



(d) Determine the horizontal and vertical deflections at C. Take AE as constant. 20



2. (a) Three forces of magnitude 150N, 300N and 500N are acting at the origin O (0, 0, 0) and are directed from the points A (3, 2, 4), B (3, – 2, – 4) and C (– 1, – 3, – 4) respectively to the origin. Determine the magnitude of the resultant. And explain the types of friction with examples. 20

(b) (i) Define Mohr's theorems. 8

(ii) Write the difference between the Stiffness methods and Flexibility methods of structural analysis. 12

(c) A Cantilever beam of length 2a is carrying a load of W at the free end, and another load

W at its centre. Determine the slope and deflection of the cantilever at the free end. (By conjugate beam method). 20

3. (a) A three-hinged parabolic arch hinged at the supports and at the crown has a span of 24m and a central rise of 4m. It carries a concentrated load of 50kN at 18m from let support and a uniformly distributed load of 30kN/m over the left-half portion. Determine the moment, thrust and radial shear at a section 6m from the left support. 20

(b) Design a slab for a hall measuring 3.5m × 5.6m. The slab has to carry a live load of 3.0 kN/m, the floor finish weighs 1 kN/m^2. The slab is having all its four edges continuous. All the corners of the slab are held down. Design all the permanent reinforcements. Details the reinforcement with good sketches. 20

(c) Design a simply supported, reinforced concrete beam of rectangular cross-section using the following data: 20

Clear span between supports = 5.00 m

Width of wall supporting the beams = 230 mm

Width of the beam = 230 mm

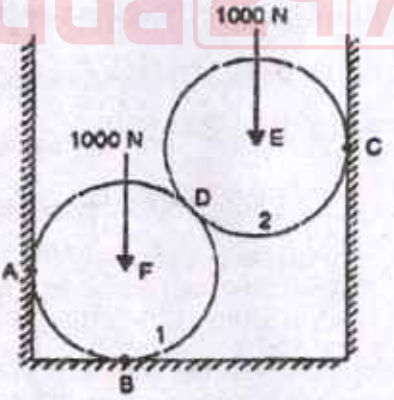
Overall depth is limited to 500 mm

Effective cover = 50 mm

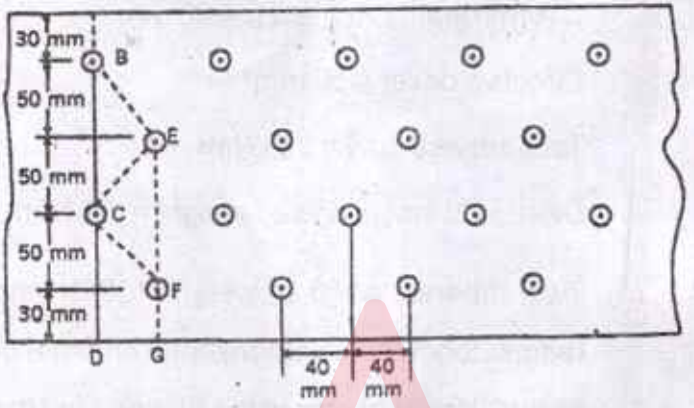
Total service load = 25 kN/m ;

Dead load including self-weight = 15kN/m

4. (a) Two spheres, each of weight 1000N and radius 25cm rest in a horizontal channel of width 90cm as shown in the Figure. Find the reactions on the points of contact A, B and C. 20



(b) Find the strength of the 12 mm thick plate shown in Figure. All the holes are 21.5 mm as gross diameter. Take $f_t = 150\ N/mm^2$. 20



(c) A rectangular beam, simply supported over a span of 5m, is carrying a UDL of 60kN/m. If the depth of the beam is 2.5 times its width and the maximum bending stress in the beam is limited to 75 MPA, calculate the dimensions of the beam. 20

SECTION – B

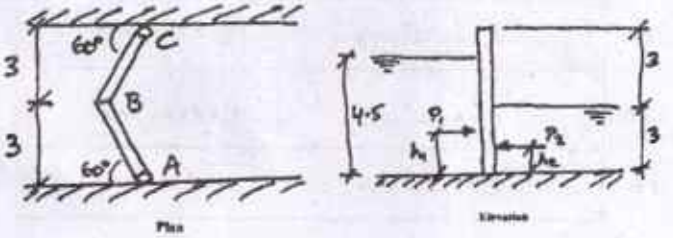
5. Answer any **three** questions of the following :

(a) Define, in brief, the "impulse-momentum theorem" ? Derive with adequate steps the impulse-momentum theorem. 20

(b) Draw the variation of total stress, effective stress and pore pressure upto 6m depth for the given data : Specific gravity of soil solids = 2.65, $\gamma d = 18 kN/m^3$, Water content = 12%. The water table is at the depth of 2 m below the ground. 20

(c) A rectangular footing has a size of 2.0m × 3.0m has to transmit the load of a column at a depth of 2.0m. Calculate the safe load which the footing can carry at a factory of safety of 3 against shear failure. Use IS code method. The properties of soft rock/soil are $\gamma = 17.2\ kN/m^3$, $\Phi = 34$, $c = 12\ kN/m^2$. For $\Phi = 34^o$ $N_c = 42.16$, $Nq = 29.44$, $N_\gamma = 41.06$. Assume the load is vertical. 20

(d) Calculate the forces on the hinges supporting the canal gates as shown. The hinges are located 0.6 m from the top and bottom of each gate. 20

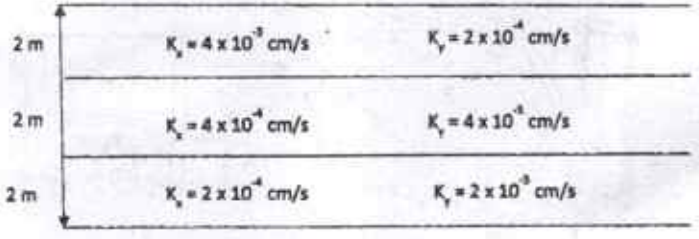


(i) Differentiate Standard Proctor and Modified Proctor tests. 10

(ii) What do you understand by the most economical channel with respect to the flow of fluid ? Develop the criteria for the most economical rectangular section of a channel. 10

(b) Oil flows through a 25 mm diameter pipe with a mean velocity of 0.3m/s. Given that the viscosity 4.8×10^{-2} kg/ms and the density 800kg/m^3. Calculate friction head loss, resultant pressure drop in 45m length, maximum velocity and velocity at 5mm from wall. 20

(c) The horizontal and vertical permeabilities of three-layered soil is shown in the below Figure. Calculate the equivalent coefficient of permeabilities in the x and y directions. 20



7. (a) A 4m high vertical wall supports a saturated cohesive soil having horizontal surface. The top 2.5m of the backfill has $\gamma = 17.6 kN/m^3$ and $c = 15 kN/m^2$; bottom 1.5m of the backfill has $\gamma = 19.2 kN/m^3$ and $c = 20 kN/m^2$. If tension cracks develop, what would be the total active pressure developed in the wall ? 20

(b) 2m square footing is resting on a clay at a depth of 1.5m below ground level. The total thickness of clay deposit is 3.5m below ground level. Clay rest over a firm sand the clay has following. W_L 30%, G for solids = 2.7 DOS = 100%, natural WC = 35%, position of water table at ground level. Unit cohesion – $0.45 Kg/cm^2$ friction angle of soil = 0°, FOS = 3. Find safe bearing capacity of soil at the base of foundation using Skempton's theory. 20

(c) Design a friction pile group to carry safe load of 300 tonne over a uniform clay deposit of 20m resting over a rock. The average unconfined compressive strength of clay is

7 tonne\m^2. Adopt FOS as 3 and adhesion factor = 0.6 calculate D, n Spacing and 1. 20

8. (a) A circular column 40cm in diameter carries a load of 72 tonne. Design a circular footing for the column when M150 concrete is used. Allowable bearing capacity of the soil may be taken as 20 tonne\m^2. 20

(b) A U tube manometer is used to measure the pressure of water in a pipe line, which is in excess of atmospheric pressure. The right limb of the manometer contains water and mercury is in the left limb. Determine the pressure of water in the main line, if the difference in level of mercury in the limb U tube is 10cm and the free surface of mercury is in level with over the centre of pipe. If the pressure of water in pipe line is reduced to 9810N/m^2, Calculate the new difference in the level of mercury. Sketch the arrangement in both the cases. 20

(c) A natural soil deposit has 9 bulk unit weight of 18.44kN/m^3 and water content of 5%. Calculate the amount of water required to be added to raise the water content to 15%. Assume void ratio to be constant. What will be the percentage of saturation (G = 2.67) ? 20