Size of column = 45 × 45 cm
Concrete grade = M 25, Steel grade = Fe 415
Factored load P_u = 1000 kN
Factored moment M_{ux} = 75 kNm and M_{uy} = 60 kNm.

5 + 7 = 12

Group – E

8. Design an isolated footing for a column, 300 mm × 500 mm, reinforced with 6-25φ bars with Fe 415 steel and M 25 concrete subject to a factored axial load P_u = 1350 kN and a factored uniaxial bending moment of 100 kN-m (with respect to major axis) at the column base. Assume that the moment is entirely due to dead loads and hence irreversible. The Safe bearing capacity of soil may be taken as q = 200 kN/m² at a depth of 1.5 m. Unit weight of soil = W_e = 19 kN/m³. Angle of repose = φ = 30°. Use M 20 concrete and Fe 415 steel for the footing.

12

9. A RC column of size 500 mm × 500 mm is supported on four piles of 300 mm diameter. The column carries a load of 100 KN, a moment of 300 kN-m in the x-x direction, and a shear force of 50 kN on top of the pile. Design the pile cap assuming M 25 concrete and Fe 415 steel. Further, assume that the piles are capable of resisting the reaction from the pile cap.

12

DESIGN OF R. C. C. STRUCTURES
(CIVL 3105)

Time Allotted : 3 hrs **Full Marks : 70**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 5 (five) from Group B to E, taking at least one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A
(Multiple Choice Type Questions)

1. Choose the correct alternative for the following: **10 × 1 = 10**

(i) Design stress for Fe 415 is
(a) 350 N/mm² (b) 415 N/mm²
(c) 361 N/mm² (d) 400 N/mm²

(ii) The area of stress block is:
(a) 0.3 $f_{cu}x_u$ (b) 0.36 $f_{ck}x_u$
(c) 0.3 $f_y x_u$ (d) 0.36 $f_y x_u$

(iii) In public staircase, the risers' height is usually kept as
(a) 100 mm (b) 250 mm (c) 200 mm (d) 150 mm.

(iv) Short columns fail by
(a) Buckling (b) Bending (c) Crushing (d) Tension.

(v) For a RCC column effectively held in position and restrained against rotation at one end and at the other restrained against rotations but not held in position, the effective length is
(a) 1.2 (b) 0.8 (c) 1.00 (d) 1.5.

(vi) Design of a two way slab simply supported on all its four edges and having no provision to prevent the corner from lifting, is made by
(a) Rankine's formula (b) Rankine' Grashoff formula
(c) Marcus formula (d) Elastic formula.

(vii) Magnitude of minimum reinforcement recommended for reinforced concrete using mild steel in slabs/columns are
(a) 0.15%/0.6% (b) 0.25%/0.8%
(c) 0.50%/1.00% (d) 0.15%/0.80%.

(viii) A simply supported beam has an effective span of 16 m. What shall be the limiting ratio of span to effective depth as per IS 456-2000?
(a) 26 (b) 20 (c) 12.5 (d) 7.

(ix) Torsion reinforcement provided at the corners of a two way slab
(a) Distributes bending moment uniformly
(b) Prevents corners from lifting
(c) Controls cracking at corners
(d) Does not allows any twist at corners.

(x) The main reinforcement of a RC slab consists 10 mm bars at 10 cm spacing. If it is desired to replace 10 mm bars by 12 mm bars, then spacing of 12 mm bars should be
(a) 12 cm (b) 14 cm (c) 14.4 cm (d) 16 cm.

Group – B

2. (a) Determine depth of neutral axis for the section shown in Fig.1, if f_{ck} = 20N/mm², f_y = 415N/mm², x_{umax} = 0.48d.

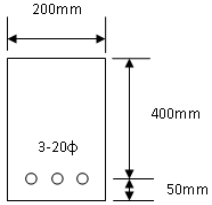


Fig.1

(b) Design a rectangular beam for 4 m effective span which is subjected to a dead load of 15 kN/m and a live load of 12 kN/m. Use M 25 mix and Fe 500 grade steel. x_{umax} = 0.46d.

6 + 6 = 12

3. A RC beam has an effective depth of 500 mm and a breadth of 350 mm. It contains 4-25 mm bars out of which two bars are to be bent up at 45⁰ near end of the support. Calculate shear resistance of the bent up bars and additional stirrups needed if the factored shear force near the support is 300 kN. Use M 25 mix and Fe 500 grade steel.

12

Group – C

4. (a) Determine the factored moment of resistance of a beam 230 mm × 460 mm (effective). The beam is reinforced with 2-16 mm diameter bars on compression face and 4-20 mm diameter bars on tension side. The

compression bars are placed at a distance of 40 mm from the top. Use M 20 concrete and Fe 415 steel.

(b) Design and detail a rectangular beam 250 mm × 600 mm for flexure over an effective span of 5.5 m. The superimposed load on the beam is 54 kN/m. Effective cover to the reinforcement is taken as 50 mm. Use M 20 concrete and Fe 415 steel.

5 + 7 = 12

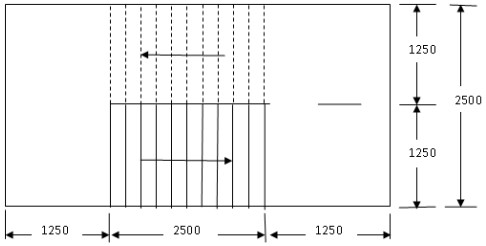
5. (a) Determine the ultimate moment of resistance of isolated singly reinforced T-beam, having a span of 6 m and cross sectional dimensions as follows- width of flange, b_f = 900 mm, width of web, b_w = 300 mm, thickness of flange, D_f = 120 mm effective depth, d_{eff} = 600 mm. Total area of steel , A_{st} = 4 numbers of 25 mm diameter bars. Assume f_{ck} = 20 MPa and grade 415 steel.

(b) The slab of a residential building of size 4.3 m × 6 m is simply supported on all the four sides on 230 mm walls. Assuming an imposed load of 2 KN/m² and load due to finishes of 1.0 KN/m², design the floor slab. Use M 25 concrete and Fe 415 steel. Assume mild exposure.

5 + 7 = 12

Group – D

6. Design a two flight staircase shown in Fig.2, with steps on waist slab for floor-to floor height of 3.5 m, width of flight equal to 1.25 m and superimposed load of 3 kN/m². It has the following support condition: Simply supported on walls of 250 mm thick at the end of landing slabs which span in the direction of flight. Consider weight of surface finish of 0.5 kN/m² and concrete of grade M 20 and steel of grade Fe 415.



All dimensions are in mm

Fig.2

12

7. (a) Design and detail a short column, square in section, to carry an axial load of 2000 kN using Fe 415 grade steel and M 20 mix concrete.

(b) Design and detail a short column under biaxial bending with the following data: