DESIGN OF R.C.C. STRUCTURES
(CIVL 3102)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

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

USE OF IS CODES ARE ALLOWED IN THE EXAMINATION HALL

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) The diameter of longitudinal bars of a column should never be less than
(a) 6 mm (b) 8 mm (c) 10 mm (d) 12 mm.

(ii) As the percentage of steel increases
(a) depth of neutral axis decreases (b) depth of neutral axis increases
(c) lever arm increases (d) lever arm decreases.

(iii) If the permissible compressive stress for a concrete in bending is C (N/mm^2), the modular ratio is
(a) 280/C (b) 2300/2C
(c) 280/3C (d) 2800/C^2.

(iv) If d and n are the effective depth and depth of neutral axis respectively of a singly reinforced beam, the lever arm of the beam is
(a) d (b) n
(c) $\left(d+\frac{n}{3}\right)$ (d) $\left(d-\frac{n}{3}\right)$.

(v) The recommended imposed load on staircase in residential buildings as per IS 875 is
(a) 5.0 kN/sqm (b) 3.0 kN/sqm
(c) 1.5 kN/sqm (d) 1.3 kN/sqm.

(vi) The minimum eccentricity to be considered for an axially loaded RCC Column of size 400 mm× 400 mm with unsupported length of 5 m is
(a) 15.6 mm (b) 20.5 mm
(c) 23.3 mm (d) 30.6mm.

(vii) The minimum and maximum percentage of longitudinal reinforcement in a RCC column as per IS 456:2000 are respectively
(a) 0.4 and 4 (b) 0.5 and 8
(c) 0.8 and 6 (d) 1 and 10.

(viii) As per IS 456-2000 shear reinforcement can be provided in the form of
(a) vertical stirrups (b) bent up bars
(c) inclined stirrups (d) all of the above.

(ix) The final deflection due to all loads including the effects of temperature, creep and shrinkage should not normally exceed
(a) span/250 (b) span/350
(c) span/150 (d) 20 mm.

(x) The value of partial safety factor for steel is
(a) 1.5 (b) 1.2
(c) 1.15 (d) 1.25.

Fill in the blanks with the correct word

(xi) The minimum number of main steel bars provided in RCC rectangular column is _____.

(xii) An R.C.C. beam not provided with shear reinforcement may develop cracks in its bottom inclined roughly to the horizontal at_____.

(xiii) In R.C.C. the coefficient of thermal expansion of concrete is nearly equal to _____.

(xiv) For limit state of collapse in flexure, maximum strain in concrete at the outermost compression fibre is taken equal to _____.

(xv) The anchorage value of a 90^0 hook is _____.

Group - B

2. (a) Estimate the safe load that an R.C.C. cantilever beam of size 300mm× 500mm effective depth reinforced with 2 bars of 16 mm diameter and span of 4m can safely carry. Use working stress method of design. Assume Fe 415 steel and M20 concrete. *[(CO1,CO4)(Evaluate/HOCQ)]*

(b) An R.C.C. beam of width 300mm× 650 mm overall depth is reinforced with 4 bars of 20 mm diameter. The beam is simply supported and has to carry a superimposed load of 60kN/m, including self weight of the beam over an effective span of 4.5 m. Evaluate the actual stresses developed in steel and concrete. Use M25 and Fe 415 steel and working stress method of design.
[(CO1,CO4)(Evaluate/HOCQ)]

6 + 6 = 12

3. (a) A simply supported R.C.C. beam 250 mm wide and 450 mm deep (effective) is reinforced with a 3-20 mm diameter bars. Design the shear reinforcement if M20 grade of concrete and Fe 415 steel is used and the beam is subjected to a shear force of 150 kN at service state. *[(CO1,CO3,CO4)(Create/HOCQ)]*

(b) An R.C.C. beam 250 mm × 500 mm has a clear span of 5.5 m. The beam has 2-20 mm bars going to in to the support. Factored shear force is 140 kN. Check for development length if Fe 415 and M20 grade of concrete is used.
[(CO3,CO4)(Create/HOCQ)]

6 + 6 = 12

Group - C

4. (a) Determine the depth of neutral axis and ultimate moment of resistance for the T-beam, having a span of 6 m and having width of flange, b_f= 850 mm, thickness of flange, D_f= 100 mm, width of web, b_w=250 mm, effective depth d_{eff}=520 mm reinforced with 6 nos. 28 mm diameter bars. Assume Fe 415 steel and M20 grade of concrete. *[(CO3,CO4,CO6)(Evaluate/HOCQ)]*

   (b) A rectangular reinforced concrete beam is simply supported with an effective length of 6.0 m. The beam has to carry, in addition to its own weight, a distributed live load of 20 kN/m. Design the flexural reinforcement for the beam such that its size is limited to 250 mm width and effective depth of 375 mm for maximum moment at mid span. Assume M25 grade of concrete and Fe 500 grade of steel. *[(CO3,CO4,CO6)(create/HOCQ)]*

6 + 6 = 12

5. Design and detail simply supported slab to cover a room with effective spans of 4.0 m×5.0 m and 250 mm thick brick walls all round. Assume a live load of 4 kN/m^2 and a finish load of 1kN/m^2. Use M20 concrete and Fe415 steel. Assume that the slab corners are restrained to lift up. *[(CO1,CO3)(apply/IOCQ)]*

12

Group - D

6. (a) An R.C.C. short column of size 400 mm×500 mm is carrying a factored load of 2500 kN factored moment of 200 kNm . Design and detail the column assuming e_{min} < 0.05D. Use M25 concrete and Fe 415 steel. *[(CO4,CO6)(Create/HOCQ)]*

   (b) Design a circular column of diameter 400 mm subjected to a load of 1200 kN. The column is having spiral ties. The column is 3m long and is effectively held in position at both ends but not restrained against rotation. Use M25 concrete and Fe 415 steel. *[(CO4,CO6)(Create/HOCQ)]*

6 + 6 = 12

7. Design and detail a dog legged stair case for an office building in a room 3.0 m × 6.0 m (clear dimensions). Floor to floor height is 3.5 m. The building is a public building liable to be overcrowding. Stairs are supported on brick walls 230 mm thick at the end of the landings. Use M20 concrete and Fe 415 steel. *[(CO4,CO6)(Create/HOCQ)]*

12

Group - E

8. Design a square footing of uniform thickness for an axially loaded column of size 450 mm × 450 mm. Load on column is 1800 kN. Safe bearing capacity of the soil is 200 kN/m^2. Use M20 concrete and Fe415 steel. *[(CO1,CO4)(create/HOCQ)]*

12

9. A precast pile of diameter 400 mm carrying an axial load of 275 kN, placed in submerged medium dense sandy soil having an angle of internal friction of 32^0. The

density of the soil is 18kN/m^3 and the submerged density of soil is 10 kN/m^3. Angle of wall friction between concrete pile and soil is δ is $0.75\phi=24^0$. Assume the following data: Depth of top of pile cap below ground level is 500 mm, thickness of pile cap is 1.5 m, grade of concrete in pile is M25, Fe 415 steel is used and clear cover to reinforcement is 75 mm. Design the pile in accordance with IS2911 (Part 1, Section1).

[(CO1,CO4)(create/HOCQ)]

12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	0	12.5	87.5

Course Outcome (CO):

After the completion of the course students will be able to

1. Understand material properties and design methodologies for reinforced concrete structures.
2. Assess different type of loads and prepare layout for reinforced concrete structures.
3. Identify and apply the applicable industrial design codes relevant to the design of reinforced concrete members.
4. Analyse and design various structural elements of reinforced concrete building like beam, slab, column, footing, and staircase based on both strength and serviceability criteria.
5. Understand the basic concept and mechanical behaviour of prestressed concrete
6. Prepare structural drawings and detailing and produce design calculations and drawing in appropriate professional format.

**LOCQ: Lower Order Cognitive Question; IOCQ: Intermediate Order Cognitive Question; HOCQ: Higher Order Cognitive Question.*