DESIGN OF RCC STRUCTURES
(CIVL 3102)

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) The modular ratio for M25 grade of concrete is
(a) 18.67 (b) 13.33 (c) 10.98 (d) 9.33.

(ii) For Fe 415, the neutral axis depth factor as per working stress method of design is
(a) 0.4 (b) 0.29 (c) 0.254 (d) 0.3.

(iii) Minimum nominal cover for concrete subjected to coastal environment
(a) 20 mm (b) 30 mm (c) 45 mm (d) 50 mm.

(iv) As per the individual test results acceptance criteria of IS 456:2000 any sample of M25 grade concrete is acceptable if individual result is greater than
(a) 21 N/mm2 (b) 22 N/mm2 (c) 23 N/mm2 (d) 24 N/mm2.

(v) If a column has an unsupported length l and it is effectively held in position at both ends, but not restrained against rotation, then the relation between its length l and its effective length l_e, as per IS 456:2000 is
(a) $l_e = l$ (b) $l_e = 0.8\, l$ (c) $l_e = 1.2\, l$ (d) $l_e = 2\, l$.

(vi) The percentage of longitudinal steel based on gross cross sectional area of a column should have a value between
(a) 0.12 and 0.8 (b) 0.15 and 8 (c) 0.2 and 6 (d) 0.8 and 6.

(vii) Spacing of stirrups in beams of effective depth 'd' should not be more than
(a) 0.5 times of effective depth (d) (b) 300 mm
(c) 0.75 times of effective depth (d) (d) smaller of (B) and (C).

(viii) Given f_y =415 N/mm2 , f_{ck} =20N/mm^2 , then the development length L_d for deformed bars will be
(a) 71.8φ (b) 64.47φ (c) 75.2φ (d) 47φ.

(ix) In limit state method of design, the maximum ($x_{u,max}$ /d) values using M20 and M25 grade concrete and Fe 415 grade steel (for both cases) are
(a) 0.53, 0.48 (b) 0.53, 1.50 (c) 0.48, 0.48 (d) 0.48, 0.53.

(x) For a particular grade of concrete and with lowering the grade of steel, the $P_{t,lim}$
(a) decreases
(b) increases
(c) remain constant
(d) sometimes increases and sometimes decreases.

Group- B

2. (a) Classify the philosophies of design of reinforced concrete structure. [(CO4)(Understand/LOCQ)]

(b) A beam of width 250mm, overall depth 500mm. Determine the area of steel for balance section. Assume grade of concrete M25 and grade of steel Fe 500.Use working stress method of design. [(CO2)(Evaluate/HOCQ)]

(c) Estimate the stresses developed in a beam of width 350 mm, overall depth 650 mm due to bending moment 310 KNm. Area of tension steel is 4 nos. 25 mm dia. Consider M30 concrete and Fe 415 grade of steel. Use working stress method. [(CO1)(Evaluate /HOCQ)]

3 + 4 + 5 = 12

3. (a) If three cube test results are 27.5, 28.6 and 29 N/sq.mm. Examine whether these are acceptable for M25 grade concrete based on acceptance criteria of IS 456:2000. [(CO3)(Analyze/LOCQ)]

(b) Solve the development length required for 20 mm diameter bars reinforcement (HYSD) used with M25 concrete (in LSM) for (i) bars in tension (ii) bars in compression. Use Fe 500 grade of steel. [(CO4)(Apply/IOCQ)]

6 + 6 = 12

Group - C

4. Design a rectangular beam 250 mm × 550 mm over an effective span of 5m. The superimposed load on the beam is 50 kN/m. Effective cover to reinforcement is taken as 50 mm. Use M20 concrete and Fe 415 steel. [(CO3, CO4, CO6)(Create/HOCQ)]

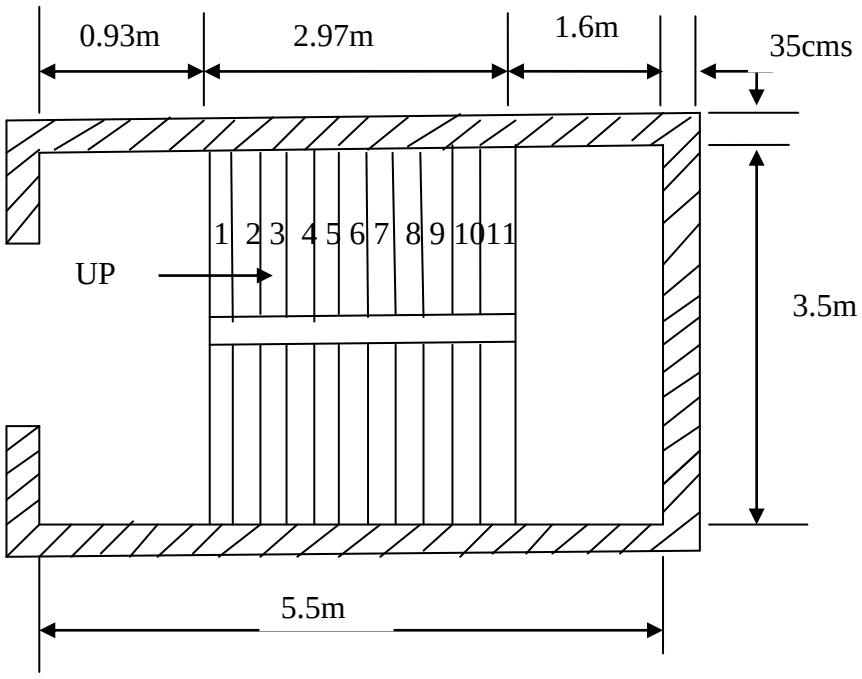
12

5. A floor consists of 150 mm thick slab monolithically constructed with 300 mm wide beams spaced at 3.6 m centre to centre spacing. The effective span of the beam is 5m. The slab is subjected to a superimposed load of 5 kN/m^2. Design an intermediate beam. Use M20 concrete and Fe 415 steel. [(CO3, CO4, CO6)(Create/HOCQ)]

12

Group - D

6. The main stair of an office building having two flights has to be located in a space measuring 3.5m×5.5m. The vertical distance between the floors is 3.75 m. Design the stairs. Allow a L.L. of 2000 N/m^2. Use M20 concrete and Fe 415 steel.



[(CO2, CO3, CO4)(Create/LOCQ)]
12

7. A short rectangular R.C.C. column carries an axial load of 1170 kN accompanied by moments M_x =120kNm and M_y =30kNm about the major and minor axes.
Effective length about x-axis=l_{ex} =5.25 m
Effective length about y-axis =l_{ey} =4m
Unsupported length of column about both axes = 4.75 m.
Illustrate the cross section of the column using M20 concrete and Fe 415 steel.
Reinforcement shall be arranged equally on four sides.
[(CO2, CO3, CO4, CO6)(Apply/IOCQ)]
12

Group - E

8. (a) What is pretension prestressed concrete? Write its advantages and limitations.
[(CO5)(Remember/LOCQ)]
(b) Write the difference between stress and force based concept of analyses at transfer and service of prestressed concrete. [(CO5)(Understand/LOCQ)]
(c) A concrete beam 450 mm wide and 700 mm deep is prestressed with a parabolic tendon and subjected to uniformly distributed load of 46KN/m (including the self weight). The beam is simply supported and span of 8m. The prestressing force applied is 1620 KN. Evaluate and draw the extreme fibre stress at the mid span where maximum eccentricity is 140 mm. [(CO5)(Evaluate/HOCQ)]
4 + 3 + 5 = 12

9. Design and detail an isolated footing for a 300mm × 500mm column subjected to an axial load of 1500KN and bending moment of 75KNm. Assume the safe bearing capacity of soil at a depth of 2m below FGL is 200KN/m^2. Consider M25 grade of concrete and Fe 500 steel. [(CO4, CO6)(Create/HOCQ)]
12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	29	19	52

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