DESIGN OF RCC 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.

N.B.: STUDENTS ARE ALLOWED TO USE RELEVANT CODES SUPPLIED.

Group – A
(Multiple Choice Type Questions)

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

(i) The acceptable limit of safety and serviceability before failure occurs is called as
(a) ultimate state (b) failure state
(c) limit state (d) working state.

(ii) The anchorage value of a 90° hook is
(a) 12φ (b) 16φ (c) 15φ (d) 8φ.

(iii) The maximum strain in steel at failure is
(a) $\frac{f_y}{1.15E_s}+0.002$ (b) 0.002
(c) $\frac{f_y}{1.15E_s}+0.0035$ (d) 0.0035.

(iv) Modular ratio for compression steel is taken as
(a) 2.0 m (b) 1.8 m (c) 1.5 m (d) 1.0 m.

(v) The factor of safety used for concrete is
(a) 1.5 (b) 1.15 (c) 1.3 (d) 2.0.

(vi) The maximum strain in concrete at the outer most fibre is
(a) 0.002 (b) 0.003 (c) 0.0035 (d) 0.0025.

(vii) Isolated footings are not designed for
(a) bending moment (b) one-way shear
(c) two-way shear (d) torsion.

(viii) The minimum percentage of steel in longitudinal direction in a column is
(a) 1.0% (b) 0.8% (c) 0.5% (d) 0.7%.

(ix) The centre to centre distance of distribution bars in a slab shall not exceed
(a) 300 mm (b) 350 mm
(c) 400 mm (d) 450 mm.

(x) As per IS codal provisions, critical section for two way shear is taken as
(a) face of the column
(b) a distance equal to effective depth from the face of column
(c) a distance equal to half the effective depth from the face of the column
(d) a distance equal to width of the column

Group – B

2. (a) (i) Give the stress block parameters used in limit state method along with the stress diagram.

(ii) Derive an expression to determine the depth of neutral axis for an under reinforced rectangular section using limit state method of design.

(b) A simply supported rectangular beam 250 mm width and 400 mm depth (effective) carries an udl of 35 kN/m over a clear span of 3.0 m. It is reinforced with 5 - 20 mm diameter bars, out of which 3 bars are bent up near the supports of 300 mm thick wall. Check for development length at support. Use M20 grade concrete and Fe 415 grade of steel.

(3 + 3) + 6 = 12

3. (a) Find the moment of resistance of a R.C.C beam 300 mm wide and 500mm effective depth is reinforced with 3 bars of 16mm. Use M 20 concrete and Fe 415 steel. (Use working stress method of design.)

(b) What do you understand by development length? Write the expression to find the development length of bars in tension.

9 + (2 + 1) = 12

Group – C

4. (a) A simply supported R. C. C beam over a clear span of 7 m carrying an imposed load of 30 kN/m. Design the beam with all necessary checks using M 25 concrete and Fe 415 steel. Use limit state method of design.

(b) Find the M_r of a T- beam section having the following details:
B_f = 700 mm, d = 350 mm, b_w = 250 mm
A_{st} = 5 bars of 20 mm diameter (Fe-415), D_f = 100 mm, M 20 grade of concrete.

7 + 5 = 12

5. (a) Explain the steps to follow for the design of one way slab.

(b) Design a reinforced concrete slab for a room of clear dimension 4 m × 5 m. The slab is supported on walls of width 300 mm. The slab is carrying a live load of 4 kN/m^2 and floor finish 1 kN/m^2. Use M 20 concrete and Fe 415 steel.

3 + 9 = 12

Group – D

6. Design a dog-legged staircase for an office building given the following data:
Floor to floor height is 3.2 m.
Riser = 160 mm, Tread = 270 mm
Width of flight = Landing width = 1.30 m
Live load = 5 kN/m^2
Floor finishes = 0.6 kN/m^2
Assume the stairs to be supported on 230 mm thick masonry walls at the outer edges of the landing parallel to riser. Use M 20 concrete & Fe 415 steel. Assume mild exposure condition.

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7. (a) Find the ultimate load carrying capacity and allowable load for a short column of size 500 mm × 500 mm. The column is reinforced with 4 - 25 mm diameter bars. Use M 20 concrete and HYSD grade Fe 415 steel assume $e_{min} < 0.05$ D.

(b) Design a short R. C. C column to carry an axial load of 1600 kN. It is 4 m long effectively held in position and restrained against rotation at both ends. Use M 20 concrete and Fe 415 steel.

5 + 7 = 12

Group – E

8. Design a rectangular R.C.C footing for a column of 400 mm × 600 mm subjected to a load of 1200 kN and uniaxial bending moment of 400 kN-m at service state. Unit weight of soil = W_e = 19 kN/m^3. Angle of repose = φ = 30°. Safe bearing capacity of soil q= 150 kN/m^2. Use M 20 concrete and Fe 415 steel.

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9. Design Pre-cast pile to carry a R.C.C column with axial load 1200 kN.
- Uniaxial moment = 75 kN-m
- Shear Force = 70 kN

Field investigation -
- Soil = medium sand
- Angle of repose φ = 30°
- K = 1.25
- Unit weight γ = 19.5 kN/m^3
- Permanent surcharge q_0 = 24 kN/m^2

Use M 20 concrete and Fe 415 steel.

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