12 CHAPTER

Compression Members

Q.1 The limit of percentage 'p' of the longitudinal reinformcement in a column is
(a) 0.15% to 2% (b) 0.8% to 4%
(c) 0.8% to 6% (d) 0.8% to 8%

Q.2 Given that d = effective depth, b = width and D = overall depth, the maximum area of compression reinforcement in a beam is
(a) 0.04 bd (b) 0.04 bD
(c) 0.12 bd (d) 0.12 bD

Q.3 Lateral ties in RC column are provided to resist
(a) bending moment.
(b) shear.
(c) buckling of longitudinal steel bars.
(d) both bending moment and shear.

Q.4 In a pedestal, the factor by which the effective length should not exceed the least lateral dimension is
(a) 2 (b) 3
(c) 4 (d) 5

Q.5 Which of the following are the additional moment considered for design of slender compresion member in lieu of deflection in X and Y direction?

(a) $\frac{Pu.l_{ux}}{200D}$ and $\frac{Pu.l_{oy}^2}{2000D}$

(b) $\frac{Pu.l_{ox}}{2000D}$ and $\frac{Pu.l_{oy}}{2000D}$

(c) $\frac{Pu.l_{ox}^2}{2000D}$ and $\frac{Pu.l_{oy}^2}{2000D}$

(d) $\frac{Pu.l_{ox}^2}{200D}$ and $\frac{Pu.l_{oy}^2}{200D}$

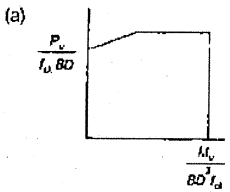
Q.6 What is the minimum number of longitudinal bars provided in a reinforced concrete column of circular cross-section
(a) 4 (b) 5
(c) 6 (d) 8

Q.7 An axially loaded column is of 300 mm x 300 mm size. Effective length of column is 3 m. What is minimum eccentricity of the axial load for the column?
(a) 0 (b) 10 mm
(c) 16 mm (d) 20 mm

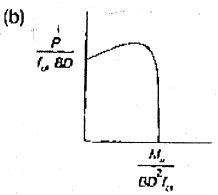
Q.8 In an axially loaded spirally reinforced short column, the concrete inside the core is subjected to
(a) bending and compression.
(b) biaxial compression.
(c) triaxial compression.
(d) uniaxial compression.

Q.9 A rectangular reinforced column ($B \times D$) has been subjected to unaxial bending moment M and axial load P. Characteristic strength of concrete is f_{ck}. Which one among the following column design cruves represents the relation between M and P qualitatively?

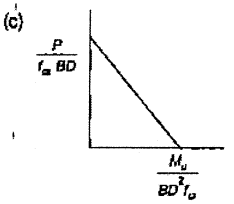
(a)



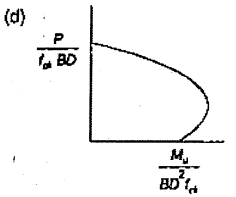
(b)



(c)



(d)



Q.10 If the load acting on a commonly conventinoal sized RC column increase continuously from zero to higher magniudes, the magnitude of the uniaxial ultimate moment that can allowed on the column,
(a) increases
(b) decreases
(c) increases and then decreases
(d) remains constant

Q.11 The load carrying capacity of a helically reinforced column as compared to that of tied column is
(a) 6% more. (b) 10% more.
(c) 5% more. (d) 7% more.

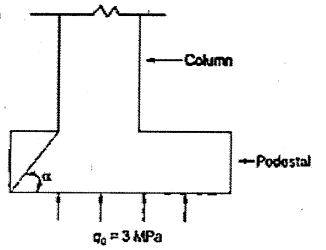
Q.12 In evaluating the slenderness effects during lifting of slender beams, following factors are considered:
1. Beam geometry
2. Method of lifting
3. Location of lifting points
4. Tolerances in construction

The correct answer is
(a) 1, 2 and 3 (b) 1, 3 and 4
(c) 2, 3 and 4 (d) 1, 2, 3 and 4

Q.13 The minimum eccentricity for the design of column is
(a) $\frac{l}{600}+\frac{b}{30}$ (b) $\frac{l}{500}+\frac{b}{30}$
(c) $\frac{l}{300}+\frac{b}{50}$ (d) $\frac{l}{300}+\frac{b}{30}$
subjected to a minimum of 20 mm.
Here l is unsupported length of the column, b is least lateral dimension of column.

Q.14 If in any given plane, one end of a column is unsupported then its unsupported length 'l' shall not exceed
(a) $100\frac{b^2}{D}$ (b) $100\frac{b^3}{D}$
(c) $100\frac{b}{D^2}$ (d) $100\frac{b^3}{D^2}$
where b is width of the cross-section and D is the depth of the cross-section measured in plane under consideration.

Q.15



A concrete pedestal made of M20 mix is shown in figure. The tan α value in this case will be
(a) not less than 3.5
(b) less than or equal to 3.6
(c) greater than 3.6
(d) greater than or equal to 3.6

Q.16 The reduction coefficient for a reinforced concrete column with an effective length of 4.8 m and size 250 x 300 mm is
(a) 0.80 (b) 0.85
(c) 0.90 (d) 0.95

Q.17 An R.C. short column with 300 mm x 300 mm square cross-section is made of M20 grade

concrete and has 4 numbers, 20 mm diameter longitudinal bars of Fe415 steel. It is under the action of a concentric axial compressive load. Ignoring the reduction in the area of concrete due to steel bars, the ultimate axial load carrying capacity of the column is

(a) 1659 kN (b) 1548 kN
(c) 1198 kN (d) 1069 kN

Q.18 For a rectangular column ($b \times D$) with 4% steel distributed equally on two faces, the ultimate axial force corresponding to minimum eccentricity is (Take M 20 concrete and Fe 250 steel)

(a) 0.72 bD (b) 10.00 bD
(c) 14.40 bD (d) 17.26 bD

Q.19 A square column section of size 350 mm × 350 mm is reinforced with four bars of 25 mm diameter and four bars of 16 mm diameter. Then the transverse steel should be

(a) 5 mm dia @240 mm c/c
(b) 6 mm dia @250 mm c/c
(c) 8 mm dia @250 mm c/c
(d) 8 mm dia @350 mm c/c

Q.20 The spacing of longitudinal bars measured along the periphery of a column should not exceed

(a) 200 mm (b) 250 mm
(c) 300 mm (d) 500 mm

Q.21 Which of the following failure mode represents the flexural collapse in over-reinforce beams?

(a) Primary tension failure
(b) Secondary compression failure
(c) Primary compression failure
(d) Secondary tension failure

Q.22 The fulcrum of the strain profile of a short column is a point through which

(a) the strain profiles causing compression failure will pass
(b) the strain profiles causing balanced future will pass.
(c) the strain profiles having no tension and causing compression failure will pass.
(d) the strain profiles causing tension failure will pass.

Q.23 The reinforcement in a short column of size 400 mm × 600 mm subjected to axial load of 2000 kN under service dead load and live load as per IS 456 : 2000; (Use M25 concrete and Fe415 steel)

(a) (6 – 20 mm ϕ + 2 – 16 mm ϕ) bar
(b) (5 – 20 mm ϕ + 1 – 16 mm ϕ) bar
(c) (4 – 20 mm ϕ + 2 – 16 mm ϕ) bar
(d) (3 – 20 mm ϕ + 3 – 16 mm ϕ) bar

Q.24 As per IS : 456 code recommendations the ratio of volume of the helical reinforcement to the volume of core shall not be less than which of the following?

(a) $0.36\left(\frac{A_c}{A_g}-1\right)\frac{f_{ck}}{f_y}$ (b) $0.36\left(\frac{A_g}{A_c}-1\right)\frac{f_y}{f_{ck}}$

(c) $0.36\left(\frac{A_g}{A_c}-1\right)\frac{f_{ck}}{f_y}$ (d) None of the above

Q.25 Consider a plain concrete footing for a column 300 mm × 300 mm, carrying an axial load of 330 kN (under service load due to dead and live loads). Assume M20 concrete and Fe415 steel, the value of limiting bearing stress at column-footing interface, is;

(a) 810×10^3 N (b) 1620×10^3 N
(c) 1210×10^3 N (d) 610×10^3 N

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Answers Compression Members

1. (c)	2. (b)	3. (c)	4. (b)	5. (c)	6. (c)	7. (d)	8. (c)	9. (d)	10. (c)
11. (c)	12. (d)	13. (b)	14. (a)	15. (d)	16. (b)	17. (d)	18. (c)	19. (c)	20. (c)
21. (c)	22. (c)	23. (a)	24. (c)	25. (a)					

Explanations Compression Members

7. (d)

$$e_{min} \geq \begin{cases} \frac{l}{500}+\frac{D}{30} \\ 20\text{ mm} \end{cases}$$

$$= \begin{cases} \frac{3000}{500}+\frac{300}{30} \\ 20\text{ mm} \end{cases}$$

$$= \begin{cases} 16\text{ mm} \\ 20\text{ mm} \end{cases} = 20\text{ mm}$$

8. (c)
Spirally reinforced columns have the bars and the core concrete wrapped with closely spaced helix. The spiral reinforcement has the confining effect of concrete in the core. Thus, core is subjected to triaxial compression.

11. (c)
According to clause 39.4 of IS 456 : 2000 the strength of compression member with helical reinforcement shall be taken as 1.05 times the strength of similar member with lateral ties.

13. (b)
According to clause 25.4 of IS 456 : 2000.

14. (a)
According to clause 25.3.2 of IS 456 : 2000.

15. (d)

$$\tan\sigma \leq 0.9\sqrt{\frac{100q_0}{\sigma_{ck}}+1}$$

$$\leq 0.9\sqrt{\frac{100\times 3}{20}+1}$$

$$\leq 0.9\times 4$$

$$\leq 3.6$$

16. (b)
Reduction coefficient

$$C_r = 1.25-\frac{l_{eff}}{48b}$$

$$= 1.25-\frac{4800}{48\times 250} = 0.85$$

17. (d)

$$P_u = 0.4\, f_{ck}A_c + 0.67\, f_y A_{sc}$$

$$A_{sc} = 4\times\frac{\pi}{4}\times 20^2$$

$$= 1256.64\text{ mm}^2$$

$$A_c = 300^2\text{ mm}^2$$

$$\therefore \quad P_u = 0.4\times 20\times 300^2 + 0.67 \times 415 \times 1256.64\text{ N}$$

$$= 1069\text{ kN}$$

19. (c)
The diameter of transverse reinforcement shall not be less than one fourth of the diameter of the largest longitudinal bar and in no case less than 6 mm. So the diameter of the bar $\frac{25}{4} = 6.25$ mm.

Choose 8 mm diameter bar.

The pitch of the transverse reinforcement shall not be more than the least of the following:

(i) The least lateral dimension of the compression members i.e. 350 mm.
(ii) Sixteen times the smallest diameter of the longitudinal reinforcement bar to be tied i.e. $16 \times 16 = 256$ mm
(iii) 300 mm

So pitch will be 250 mm c/c

0. (c)
As per IS 456 : 2000
The spacing of longitudinal bars measured along the periphery of a column should not exceed 300 mm.

1. (c)
Secondary compression failure of concrete occurs in under reinforcement section in which steel fails first and finally failure occurs due to gradual increase of strain in concrete. When steel starts yielding and finally concrete getting crushed called secondary compression failure.
In over-reinforced section, the failure occurs due to direct failure of concrete that reach to failure strain 0.0035 first.

2. (c)
Fulcrum of strain profiles passes through point of no tension and causes compression failure.

3. (a)
As per IS : 456,
Factored load carrying capacity of short column,

$$P_u = 0.4 f_{ck} A_s + 0.67 f_y A_{sc}$$

$$\Rightarrow \quad 3000 = 0.4 \times 25 \times [(400 \times 600) - A_{sc}] + 0.67 \times 415 A_{sc}$$

Which gives; $A_{sc} = 2238.39\,mm^2$
Provide 6–20 mm ϕ and 2–16 mmϕ bar giving $2287\,mm^2 (> A_{sc})$

24. (c)

$$\frac{\text{Volume of helical reinforcement}}{\text{Volume of core}} = 0.36\left(\frac{A_g}{A_c} - 1\right)\frac{f_{ck}}{f_y}$$

in order to apply additional strength factor of 1.05 in case of spiral columns.

25. (a)
As per IS 456;
Limiting bearing stress,

$$f_{br,max} = 0.45 f_{ck}\sqrt{\frac{A_1}{A_2}}$$

At the column-footing interface, $f_{br,max}$ will be governed by the column face in this case with $A_1 = A_2 = (300 \times 300)\,mm^2$

$$\therefore \quad F_{br} = 0.45 \times 20 \times (300)^2$$

$$F_{br} = 810 \times 10^3\,N$$

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