

Basic Design Concepts

Q.1 In reinforced concrete walls the

1. minimum ratio of vertical reinforcement to gross concrete area shall be 0.0012 for deformed bars not larger than 16 mm in dia, with a characteristic strength of 415 N/mm² or greater.
2. the minimum ratio of horizontal reinforcement to gross concrete area shall be 0.0020 for deformed bars not larger than 16 mm in diameter with a characteristic strength of 415 N/mm² or greater.
3. horizontal reinforcement shall be spaced not farther apart than three times the thickness of the walls nor 450 mm.

Which of these statements is/are correct?

- (a) Both 1 and 2
- (b) Both 2 and 3
- (c) Both 1 and 3
- (d) 1, 2 and 3

Q.2 In cantilever retaining walls, expansion and contraction joints are provided at an interval of

- (a) 30 m
- (b) 40 m
- (c) 50 m
- (d) 20 m

Q.3 In counterfort retaining walls, the counterforts are provided at a spacing of

- (a) 3 to 3.5 m
- (b) 1.5 to 2.0 m
- (c) 4 to 5 m
- (d) 5 to 6 m

Q.4 The nature of shrinkage stresses in concrete and steel in symmetrically reinforced sections are respectively

- (a) tensile and compressive
- (b) both compressive
- (c) compressive and tensile
- (d) none of the above

Q.5 In a simply supported beam of composite construction, the deflection due to

1. dead load, live load and impact load shall not exceed 1/600 of the span
2. live load and impact load shall not exceed 1/800 of the span
3. live load and impact load shall not exceed 1/500 of the span

Which of these statements is/are correct?

- (a) only 3
- (b) both 1 and 2
- (c) only 2
- (d) both 1 and 3

Q.6 Consider the following statements:

The design for the limit state of collapse in flexure is based on the following assumptions:

1. Plane sections normal to the axis remain plane after bending.
2. The maximum strain in concrete at the outermost tension fibre is 0.0035.
3. The relationship between the compressive stress distribution in concrete and the strain in concrete may be assumed to be rectangular, trapezoidal, parabolic or any other shape which results in prediction of strength in substantial agreement with the results of tests.

Select the correct answer using the codes given below:

- (a) 1 and 3
- (b) 1, 2 and 3
- (c) 2 and 3
- (d) 1 and 2

Q.7 Consider the following statements:

Under-reinforced concrete flexural members

1. are deeper
2. are stiffer
3. can undergo larger deflection

Which of these statements is/are correct?

- (a) 1, 2 and 3
- (b) 1 and 2
- (c) 2 only
- (d) 1 and 3

Q.8 Assertion (A): Under working loads, in a reinforced concrete beam, the lever arm remains unchanged.
Reason (R): As the bending moment increases, the total compressive force and tensile force are assumed to increase in direct proportion.

- (a) both A and R are true and R is the correct explanation of A
- (b) both A and R are true but R is not a correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

Q.9 Compressive strength of concrete is taken as $0.67 f_{ck}$ and not f_{ck} because of

1. size factor which is constant for a cube of size greater than 450 mm.
2. size factor which is constant for a cube of size greater than 550 mm.
3. end friction zone which acts throughout the length of cube.
4. end friction zone which acts throughout the length of cylinder.

Which of these statements are correct?

- (a) 1 and 3
- (b) 1 and 4
- (c) 2 and 3
- (d) 2 and 4

Q.10 A curved beam is designed for

1. bending moment
2. shear
3. tension

The correct answer is

- (a) both 1 and 3
- (b) only 3
- (c) both 2 and 3
- (d) 1, 2 and 3

Q.11 The percentage of steel in a balanced section made of M20 grade of concrete and Fe415 steel in ultimate load design method is

- (a) 1.16%
- (b) 1.2%
- (c) 2.67%
- (d) 2.5%

Q.12 Match List-I with List-II regarding the minimum concrete cover to reinforcing steel and select the correct answer using the codes given below the lists:

List-I

- A. For longitudinal reinforcement in columns of size 200 mm and less, with 12 mm diameter bars as longitudinal steel.

B. For longitudinal reinforcement in beams.

C. For longitudinal bars in slabs.

D. For longitudinal bars in columns of size more than 200 mm.

List-II

1. 40 mm or diameter of bar whichever is more
2. 15 mm or diameter of bar whichever is more
3. 25 mm or diameter of bar whichever is more
4. 25 mm

Codes:

- | | A | B | C | D |
|-----|---|---|---|---|
| (a) | 4 | 3 | 2 | 1 |
| (b) | 1 | 2 | 3 | 4 |
| (c) | 1 | 3 | 2 | 4 |
| (d) | 4 | 2 | 3 | 1 |

Q.13 Consider the following specified span to depth ratios of beams satisfying the limits of vertical deflection for spans up to 10 m:

1. For higher spans, these are to be modified by multiplying the ratios by (10/span in metres)
2. For higher spans, these are to be modified by multiplying the ratios by (span in metre/10)
3. They get further modified depending on area and type of tension reinforcement
4. However, they do not change further with the area and type of compression reinforcement

Which of these statements are correct?

- (a) 1 and 3
- (b) 2 and 3
- (c) 1 and 4
- (d) 2 and 4

Q.14 Assertion (A): According to IS : 456-2000, over-reinforced sections are not permitted.

Reason (R): There is ductile failure of over-reinforced sections.

- (a) both A and R are true and R is the correct explanation of A
- (b) both A and R are true but R is not a correct explanation of A
- (c) A is true but R is false
- (d) A is false but R is true

Q.15 In the conventional prestressing, the diagonal tension in concrete

- (a) increases
- (b) decreases

- (c) does not change
(d) may increase or decrease

Q.16 As per IS : 456 : 2000, the minimum grade of concrete shall not be less than the following in structural reinforced concrete work in concrete water tanks:

- (a) M15 (b) M20
(c) M25 (d) M30

Q.17 Basic value of span to effective depth ratio for span upto 10 m in case of continuous beam for deflection control is

- (a) 7 (b) 20
(c) 26 (d) 30

Q.18 The relation between modulus of rupture f_{cr} , splitting strength f_{cs} and direct tensile strength f_{ct} is given by

- (a) $f_{cr} = f_{cs} = f_{ct}$
(b) $f_{cr} > f_{cs} > f_{ct}$
(c) $f_{cr} < f_{cs} < f_{ct}$
(d) $f_{cs} > f_{cr} > f_{ct}$

Q.19 On which one of the following concepts is the basic principle of structural design based?

- (a) Weak column strong beam
(b) Strong column weak beam
(c) Equally strong column-beam
(d) Partial weak column-beam

Answers Basic Design Concepts

1. (d) 2. (a) 3. (a) 4. (a) 5. (b)
11. (a) 12. (a) 13. (a) 14. (c) 15. (b)
21. (c) 22. (a) 23. (b) 24. (c)

Q.20 Maximum strain at the level of compression steel for a rectangular section having effective cover to compression steel as 'd' and neutral axis depth from compression face as x_u is

- (a) $0.0035 \left(1 - \frac{d}{x_u}\right)$ (b) $0.002 \left(1 - \frac{d}{x_u}\right)$
(c) $0.0035 \left(1 - \frac{x_u}{d}\right)$ (d) $0.002 \left(1 - \frac{x_u}{d}\right)$

Q.21 Design strength of concrete for limit state of collapse is

- (a) σ_{ck} (b) $0.67 \sigma_{ck} / \gamma$
(c) $0.67 \sigma_{ck}$ (d) $\gamma \sigma_{ck}$

Q.22 If creep coefficient for concrete at 7 days is K_1 and at 28 days K_2 , then

- (a) $K_1 > K_2$ (b) $K_1 < K_2$
(c) $K_2 = K_1$ (d) $K_1 \leq K_2$

Q.23 The compressive strength of concrete determined from standard cylinder as compared to that of standard cube is

- (a) more (b) less
(c) equal (d) none of these

Q.24 The static modulus of M20 grade concrete after 1 year of loading is

- (a) $5.647 \times 10^3 \text{ N/mm}^2$
(b) $15.647 \times 10^3 \text{ N/mm}^2$
(c) $10.647 \times 10^3 \text{ N/mm}^2$
(d) $20.647 \times 10^3 \text{ N/mm}^2$

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Explanations Basic Design Concepts

6. (a)
In flexure, the maximum strain in concrete at the outer most compression fibre is 0.0035.

13. (a)
The permissible value of span/effective depth ratio depends on:
(a) The basic value, that is, span and support conditions.
(b) The type and amount of tension steel.
(c) The amount of compression steel.
(d) The type of beam.

14. (c)
There is brittle failure of over reinforced beam.

15. (b)
The diagonal tension reduces.

16. (d)
As per IS 456 : 2000

Concrete used in	Minimum grade
1. Reinforced concrete	M20
2. Water tank	M30
3. Pre-tensioning	M40
4. Post-tensioning	M30

Hence option (d) is correct.

17. (c)
The basic values for span to effective depth ratio for span upto 10 m as per deflection control criteria:

Type	Span/Effective depth
1. Cantilever	7
2. Simply supported	20
3. Continuous	26

For span greater than 10 m, these values get

reduced by fraction $\frac{10}{\text{span}}$ (except cantilever).

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Example: for simply supported beam of span 15 m

$$\frac{\text{Span}}{\text{Effective depth}} = 20 \times \frac{10}{\text{Span}}$$

$$\Rightarrow \frac{L}{d} = 20 \times \frac{10}{15}$$

$$\Rightarrow \frac{L}{d} = 13.3$$

Hence option (c) is correct.

22. (a)
As per IS : 456 : 2000
Age at loading creep coefficient
7 days 2.2
28 days 1.6 $\Rightarrow k_{1(7)} > k_{2(28)}$

23. (b)
A cube of concrete is expected to have strength 15% higher than the cylindrical specimen. A cube is subjected under non-uniform triaxial compression. End effects have less effect/influence in these specimens of cylinder.

24. (c)
We know,
As per IS456:2000,

$$E_c = \frac{5000 \sqrt{f_{ck}}}{1 + 0}$$

where f_{ck} = characteristic compressive strength
 θ = Creep coefficient
= 1.1 for 1 year of loading.

$$\therefore E_c = \frac{5000 \sqrt{20}}{1 + 1.1} = 10.647 \text{ kN/mm}^2$$