10 CHAPTER
Limit State of Serviceability & Deflection

Q.1 A beam whose effective span is 'l', effective depth is 'd' and overall depth is 'D', shall be deemed to be a deep beam when the ratio of

1. $\frac{l}{D}$ is less than 2.0 for a simply supported beam
2. $\frac{l}{D}$ is less than 2.0 for a continuous beam
3. $\frac{l}{d}$ is less than 2.5 for a simply supported beam
4. $\frac{l}{D}$ is less than 2.5 for a continuous beam

Which of these statements are correct?
(a) 1 and 3
(b) 1 and 4
(c) 2 and 3
(d) 2 and 4

Q.2 At what stress does the first flexural crack appear in RCC beams made of M25 grade concrete ?
(a) 3.0 MPa (b) 3.5 MPa
(c) 4.0 MPa (d) 4.5 MPa

Q.3 The deflection including the effects of temperature, creep and shrinkage occurring after erection of partitions and the application of finishes should not normally exceed
(a) span/350 or 20 mm
(b) span/350 or 25 mm
(c) span/250 or 20 mm
(d) span/250 or 25 mm

Q.4 A reinforced concrete beam is designed for the limit state of collapse in flexure and shear. Which of the following limit states of serviceability have to be checked?
1. Deflection
2. Cracking
3. Durability

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

Q.5 A reinforced cantilever beam of span 4 m, has a cross-section of 150 × 500 mm. If checked for lateral stability and deflection, the beam will
(a) fail in deflection only.
(b) fail in lateral stability only.
(c) fail in both deflection and lateral stability.
(d) satisfy the requirement of deflection and lateral stability.

Q.6 A simply supported rectangular beam of span 20.0 m is subjected to a uniformly distributed load. The minimum effective depth required to check deflection of this beam, when modification factor for tension and compression are 0.9 and 1.1 respectively, will be
(a) 2.0 m (b) 1.8 m
(c) 1.3 m (d) 1.0 m

Q.7 For a simply supported beam of span 15 m, the minimum effective depth to satisfy the vertical deflection limit should be
(a) 600 mm (b) 750 mm
(c) 900 mm (d) more than 1 m

Q.8 Which of the following factors influence the crack widths in RC members subject to flexure, tension, or eccentric tension;
1. tensile stress in steel bars
2. thickness of concrete cover
3. diameter and spacing of bars
4. depth of member and location of neutral axis

5. Bond strength and tensile strength of concrete
(a) 1, 2, 3, 4 only
(b) 1, 2, 3 and 5 only
(c) 1, 3, 4 only
(d) All of the above

Q.9 A two-way slab (solid slab) having spans (3.5 m × 6 m) with high-strength deformed bars as reinforcement (Fe 415), is having uniformly distributed load of 2 kN/m². The minimum depth requirement of slab from service ability criteria assuming it as continuous slab;
(a) 210 mm (b) 110 mm
(c) 190 mm (d) 310 mm

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Answers Limit State of Serviceability & Deflection

1. (b) 2. (b) 3. (a) 4. (b) 5. (c) 6. (a) 7. (b) 8. (d) 9. (b)

Explanations Limit State of Serviceability & Deflection

2. (b)
Flexural strength of concrete is given by

$$f_{cr} = 0.7\sqrt{f_{ck}} = 0.7\sqrt{25}$$

$$= 0.7 \times 5 = 3.5 \text{ MPa}$$

5. (c)
For a cantilever

$$\frac{L}{d} \le 7$$

In this case

$$\frac{L}{d} = \frac{4000}{500} = 8 > 7$$

Hence it fails in deflection.
For lateral stability, L shall not exceed 25 b nor $100b^2/d$ whichever is less.
Now, $25b = 25 \times 150 \text{ mm} = 3.75 \text{ m}$
But $L = 4 \text{ m}$
Hence it fails in lateral stability also.

6. (a)

$$\frac{L}{d} = \alpha\beta\gamma\sigma\lambda$$

$\alpha = 20$
$\beta = 10/\text{span}, \gamma = 0.9, \delta = 1.1, \lambda = 1$

$$\therefore \quad \frac{L}{d} = 20 \times \frac{10}{20} \times 0.9 \times 1.1 = 9.9$$

$$\Rightarrow \quad d = \frac{20}{9.9} = 2.02 \text{ m}$$

7. (b)
For simply supported beam,

$$\frac{L}{d} \le 20$$

$$\Rightarrow \quad d \ge \frac{L}{20} = \frac{15000}{20} = 750 \text{ mm}$$

8. (d)
When limiting tensile strain of concrete is exceeded at weakest location a flexural crack will form and concrete in the regions adjoining the crack will no longer be subjected to tensile force. In all cases of applied loading, the width of crack is found to be maximum at the surface.

9. (b)
Shorter span, $l_s = 3.5 \text{ m} = 3500 \text{ mm}$
We know, $\frac{l_s}{D} = 40$
(for mild steel reinforcement)
(As per IS : 456, clause 24.1)

$$\Rightarrow \quad \frac{l_s}{D} = 40 \times 0.8$$

(for HYSD reinforcement)

$$\Rightarrow \quad D = \frac{3500}{32} = 109.375 \text{ mm}$$

$$\Rightarrow \quad D \simeq 110 \text{ mm}$$

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