

CEH501 - DESIGN OF RCC STRUCTURES (LIMIT STATE METHOD)

Part A — MCQs [1 mark each]

Unit I

1. Which IS code deals with RCC design?

- a) IS 800:2007
- b) IS 456:2000
- c) IS 875
- d) All the above

Answer: B

2. Minimum grade of concrete for RCC is:

- a) M10
- b) M15
- c) M20
- d) M25

Answer: C

3. Which of the following is NOT a limit state in RCC design?

- a) Collapse
- b) Deflection
- c) Aesthetics
- d) Durability

Answer: C

4. As per IS 456:2000, the recommended partial safety factor for steel in limit state design is:

- a) 1.5
- b) 1.15
- c) 1.0
- d) 0.87

Answer: B

5. Assume in bending, the ultimate strain in the outermost compressed fiber of concrete as per IS 456:2000 is:

- a) 0.003
- b) 0.001
- c) 0.0035
- d) 0.0045

Answer: C

6. The maximum depth of neutral axis (as a fraction of effective depth) for Fe415 steel is approximately:

- a) 0.53d
- b) 0.48d
- c) 0.61d
- d) 0.43d

Answer: B

7. Which type of section occurs when $x_u < x_{u,lim}$ in a beam?
- a) Under-reinforced
 - b) Balanced
 - c) Over-reinforced
 - d) Brittle

Answer: A

8. In under-reinforced sections:
- a) Concrete fails first
 - b) Steel yields first
 - c) Both concrete and steel fail together
 - d) None

Answer: B

9. If concrete crushes in a beam before tension steel yields, the section is:
- a) Over-reinforced
 - b) Under-reinforced
 - c) Balanced
 - d) None

Answer: A

10. Which type of beam section is more ductile?
- a) Under-reinforced
 - b) Balanced
 - c) Over-reinforced
 - d) Doubly reinforced

Answer: A

11. The lever arm (z) in flexural design is defined as:
- a) Distance between top and bottom fibers
 - b) Distance between centroid of compression and centroid of tension steel
 - c) Effective depth of the section
 - d) Distance from extreme compression fiber to neutral axis

Answer: B

12. The purpose of using doubly reinforced beams is:
- a) To increase bond strength
 - b) To reduce steel area
 - c) When depth is restricted and moment demand is high

d) To reduce concrete volume

Answer: C

13. What is the maximum area of tension reinforcement allowed in RCC beams as per IS 456:2000?

- a) 2% of gross area
- b) 4% of gross area
- c) 0.15% of gross area
- d) 1.5% of gross area

Answer: B

14. Effective depth (d) in beam refers to:

- a) Distance from top to bottom fiber
- b) Distance from top to neutral axis
- c) Distance from extreme compression fiber to center of tensile reinforcement
- d) None of these

Answer: C

15. A beam has an overall depth of 500 mm. The effective cover is 50 mm. Find the effective depth.

- a) 400 mm
- b) 450 mm
- c) 500 mm
- d) 550 mm

Answer: B

16. For an Fe415 steel beam, if the effective depth is 500 mm, the limiting neutral axis depth is:

- a) 200 mm
- b) 220 mm
- c) 240 mm
- d) 260 mm

Answer: C

17. A beam has an effective depth of 500 mm. The actual neutral axis depth is 180 mm, while the limiting neutral axis depth is 240 mm. The section is:

- a) Balanced
- b) Under-reinforced
- c) Over-reinforced
- d) Doubly reinforced

Answer: B

18. A rectangular beam has a width of 250 mm and an effective depth of 400 mm. Using Fe415 steel, the minimum area of tensile reinforcement is approximately:

- a) 150 mm²
- b) 180 mm²
- c) 205 mm²
- d) 250 mm²

Answer: C

19. Deflections of doubly reinforced beams are _____ compared to singly reinforced beams of the same depth.

- a) More
- b) Less
- c) Equal
- d) None of the above

Answer: B

20. Development length is required to ensure:

- a) Proper spacing
- b) Fire resistance
- c) Bond between steel and concrete
- d) Durability

Answer: C

21. Development length in tension is given by:

- a) $\Phi \times \sigma_s / 4\tau_{bd}$
- b) $\Phi \times \sigma_s / \tau_{bd}$
- c) $\Phi \times \sigma_s \times \tau_{bd}$
- d) Φ^2 / τ_{bd}

Answer: A

22. Effective span of a cantilever beam is:

- a) Clear span
- b) Clear span + d
- c) Clear span + 0.5d
- d) Clear span + 2d

Answer: C

23. For a simply supported RCC beam, the effective span is:

- a) Clear span
- b) Clear span + effective depth
- c) Lesser of clear span + effective depth or centre-to-centre of supports
- d) None

Answer: C

24. A cantilever beam projects 2.5 m beyond the face of the support. The effective depth is 500 mm. Determine the effective span.

- a) 2.50 m

- b) 2.75 m
- c) 3.00 m
- d) 2.25 m

Answer: B

25. A simply supported RCC beam has a span of 5 m and a characteristic bending moment of 100 kN·m. The required factored moment of resistance considering a partial safety factor of 1.5 is:

- a) 66.7 kN·m
- b) 100 kN·m
- c) 150 kN·m
- d) 50 kN·m

Answer: C

26. A beam carries a dead load of 25 kN and a live load of 15 kN. Determine the factored load using $1.5(DL + LL)$.

- a) 40 kN
- b) 50 kN
- c) 60 kN
- d) 75 kN

Answer: C

27. A simply supported RCC beam has a span of 5 m carrying a characteristic uniformly distributed load (UDL) of 16 kN/m. The design bending moment is:

- a) 60 kN·m
- b) 75 kN·m
- c) 80 kN·m
- d) 90 kN·m

Answer: B

28. The minimum nominal cover for main reinforcement in beams under mild exposure is:

- a) 50 mm
- b) 30 mm
- c) 20 mm
- d) 10 mm

Answer: C

29. Curtailment of bars is permitted when:

- a) Shear is minimum
- b) Moment is reduced
- c) Sufficient development length is available
- d) All of the above

Answer: C

30. What is the modular ratio for M50 grade concrete?

- a) 5.83
- b) 18.67
- c) 6.44
- d) 7.18

Answer: A

Unit II

1. The primary purpose of shear reinforcement in an RCC beam is to:

- a) Resist bending moment
- b) Resist diagonal tension caused by shear
- c) Increase concrete cover
- d) Reduce beam deflection

Answer: B

2. The design shear strength of concrete (τ_c) mainly depends on:

- a) Grade of steel only
- b) Percentage of tensile reinforcement
- c) Span of the beam
- d) Width of support

Answer: B

3. For a simply supported beam of length (l) under a uniformly distributed load (w), the maximum shear force at the support is:

- a) wl
- b) $wl/2$
- c) $wl/4$
- d) $wl/8$

Answer: B

4. The nominal shear stress (τ_v) in a rectangular beam is calculated using:

- a) $V_u/(bd)$
- b) $2V_u/(bd)$
- c) $V_u/(2bd)$
- d) $M_u/(bd^2)$

Answer: A

5. The critical section for shear in a beam is typically taken at:

- a) At the face of support
- b) At a distance of $L/4$ from the face of the support
- c) At the mid-span
- d) At a distance equal to the effective depth from the face of support

Answer: D

6. According to IS 456:2000, the minimum shear reinforcement in a beam is specified by:

- a) $A_{sv}/(bS_v) \geq 0.4/(0.87f_y)$
- b) $A_{sv}/(bS_v) \geq 0.2/(0.87f_y)$
- c) $A_{sv}/(bS_v) \geq 0.85/f_y$
- d) $A_{sv}/(bS_v) \geq 0.87/f_y$

Answer: A

7. The formula for the shear force resisted by vertical stirrups (V_{us}) is:

- a) $0.87f_y A_{sv} d/S_v$
- b) $0.87f_y A_{sv} S_v/d$
- c) $\tau_c b d$
- d) $\tau_v b d$

Answer: A

8. Which reinforcement is generally used to resist shear and hold longitudinal bars in position?

- a) Main bars
- b) Distribution bars
- c) Vertical stirrups
- d) Temperature reinforcement

Answer: C

9. The maximum spacing of vertical stirrups in a beam should not exceed:

- a) $0.5d$ or 300 mm, whichever is less
- b) $0.75d$ or 300 mm, whichever is less
- c) d or 300 mm, whichever is less
- d) $0.5d$ or 200 mm, whichever is less

Answer: B

10. Which of the following is NOT a type of shear reinforcement?

- a) Vertical stirrups
- b) Inclined stirrups
- c) Bent-up bars
- d) Distribution bars

Answer: D

11. For M20 grade concrete, the maximum permissible shear stress ($\tau_{c,max}$) is:

- a) 2.5 N/mm^2
- b) 2.8 N/mm^2
- c) 3.1 N/mm^2
- d) 3.5 N/mm^2

Answer: B

12. A rectangular beam of width 250 mm and effective depth 400 mm carries a

factored shear force of 80 kN. The nominal shear stress is:

- a) 0.60 N/mm²
- b) 0.80 N/mm²
- c) 1.00 N/mm²
- d) 1.20 N/mm²

Answer: B

13. A simply supported beam of span 6 m carries a uniformly distributed load (UDL) of 20 kN/m. The maximum shear force at each support is:

- a) 40 kN
- b) 50 kN
- c) 60 kN
- d) 120 kN

Answer: C

14. A beam carries a factored shear force of 90 kN. The beam width is 300 mm and the effective depth is 300 mm. The nominal shear stress is:

- a) 0.80 N/mm²
- b) 1.00 N/mm²
- c) 1.20 N/mm²
- d) 1.50 N/mm²

Answer: B

15. A reinforced concrete beam has an effective depth of 500 mm. According to IS 456:2000, the maximum permissible spacing of vertical stirrups is:

- a) 250 mm
- b) 300 mm
- c) 375 mm
- d) 500 mm

Answer: B

16. A cantilever beam of length 2.5 m carries a uniformly distributed load (UDL) of 16 kN/m. The maximum shear force at the fixed end is:

- a) 20 kN
- b) 30 kN
- c) 40 kN
- d) 50 kN

Answer: C

17. The design shear strength of concrete (τ_c) increases with an increase in:

- a) Percentage of tensile steel
- b) Grade of steel
- c) Beam depth
- d) Beam span

Answer: A

18. The main purpose of a landing in a staircase is to:

- a) Reduce the number of steps
- b) Provide a resting place and change direction
- c) Make the staircase look wider
- d) Reduce the cost of construction

Answer: B

19. The horizontal platform between two flights of stairs is called a:

- a) Tread
- b) Stringer
- c) Landing
- d) Riser

Answer: C

20. Which type of stair is supported on one end and free on the other?

- a) Geometrical Stair
- b) Cantilever Stair
- c) Dog-legged Stair
- d) Open Well Stair

Answer: B

21. What is the main feature of a dog-legged staircase?

- a) It is perfectly straight
- b) It has a central well
- c) Its flights go in opposite directions
- d) It is circular

Answer: C

22. A stair that turns 180° is called a:

- a) Dog-legged stair
- b) Open well stair
- c) Spiral stair
- d) Straight stair

Answer: A

23. The waist slab of a staircase is:

- a) Horizontal slab at the top
- b) Inclined slab supporting the steps
- c) Base of the landing
- d) Top surface of the step

Answer: B

24. Which of the following formulas is used for designing comfortable stairs?

- a) $R + T = 300$
- b) $2R + T = 600$

c) $2R + T = 630$

d) $R + 2T = 630$

Answer: C

25. The standard riser height recommended for residential buildings is approximately:

a) 75–100 mm

b) 100–120 mm

c) 150–180 mm

d) 250–300 mm

Answer: C

26. The minimum width of a staircase for residential buildings should be:

a) 600 mm

b) 750 mm

c) 900 mm

d) 1200 mm

Answer: C

27. The floor-to-floor height of a building is 3.0 m. If the height of one riser is 150 mm, the number of risers required is:

a) 18

b) 20

c) 22

d) 24

Answer: B

28. A residential building has a floor-to-floor height of 3.15 m. If the riser height is 175 mm, the number of risers required is:

a) 16

b) 18

c) 20

d) 22

Answer: B

29. What type of staircase is generally considered suitable for a public building where large numbers of people use the staircase?

a) Spiral staircase

b) Dog-legged staircase

c) Narrow winding staircase

d) Bifurcated staircase

Answer: D

30. The design shear strength of concrete (τ_c) mainly depends on:

a) Percentage of tensile reinforcement

- b) Beam span
- c) Beam length
- d) Concrete cover

Answer: A

Unit III

1. The neutral axis in a T-beam section lies:

- a) Always in the flange
- b) Always in the web
- c) May lie in the flange or web
- d) Always at mid-depth

Answer: C

2. In a T-beam or L-beam, the slab can be considered as a compression flange only if:

- a) The slab is simply supported on the web
- b) The slab is cast separately from the web
- c) The slab is cast integrally with the web or effectively bonded
- d) The slab is cast after placing the beam

Answer: C

3. In a T-beam, if the neutral axis lies within the flange, the section is treated as:

- a) Circular
- b) Doubly reinforced
- c) Flanged
- d) Rectangular

Answer: D

4. In a T-beam, the moment of resistance is calculated by considering:

- a) Flange only
- b) Web only
- c) Both flange and web
- d) Stirrups and flange

Answer: C

5. In a T-beam, if the neutral axis lies in the flange, the section is treated as:

- a) Circular
- b) Rectangular
- c) Flanged
- d) Doubly reinforced

Answer: B

6. The significance of the term $(d - D_f/2)$ in the flange moment is:

- a) Distance to the centroid of the beam

- b) Total depth of the flange
- c) Distance to the neutral axis
- d) Lever arm of the flange compression force

Answer: D

7. The permissible maximum depth of neutral axis ratio ($x_{u,max}$) for Fe500 steel as per IS 456:2000 is:
- a) 0.53d
 - b) 0.446d
 - c) 0.48d
 - d) 0.46d

Answer: D

8. The neutral axis depth of a T-beam is 220 mm, while the flange thickness is 120 mm. The beam behaves as:
- a) Rectangular beam
 - b) T-beam
 - c) Cantilever beam
 - d) Continuous beam

Answer: B

9. In the T-beam formula, the maximum allowed value of (b_f) should:
- a) Be any calculated value
 - b) Be twice the web width
 - c) Not exceed the actual flange width
 - d) Be equal to the effective span

Answer: C

10. For a T-beam section, if $D_f < 3/7 x_u$, the flange is considered:
- a) Fully effective
 - b) Partially effective
 - c) Only web is effective
 - d) Ineffective

Answer: A

11. In the effective flange width formula of a T-beam, (l_0) represents:
- a) Length of flange
 - b) Distance between points of zero moment
 - c) Span of beam
 - d) Clear cover

Answer: B

12. A continuous beam can be analysed by:
- a) Clapeyron's Three Moment Theorem
 - b) Moment Distribution Method

- c) Slope-Deflection Method
- d) All of the above

Answer: D

13. In a continuous beam, negative (hogging) bending moment generally occurs:

- a) At mid-span
- b) Near the supports
- c) At quarter span
- d) At free end

Answer: B

14. For resisting hogging moment in a continuous beam, reinforcement is mainly provided at the:

- a) Bottom
- b) Top
- c) Neutral axis
- d) Centre of web

Answer: B

15. For a continuous beam, the maximum shear force occurs:

- a) At supports
- b) At mid-span
- c) At quarter span
- d) At point of inflection

Answer: A

16. As per IS 456:2000, for continuous beams or slabs, if the support width is less than $1/12$ of the clear span, the effective span is:

- a) Clear span + Effective Depth
- b) Centre-to-centre of supports
- c) Lesser of (A) and (B)
- d) Greater of (A) and (B)

Answer: C

17. As per IS 456:2000, for continuous beams or slabs, if the support width is wider than $1/12$ of the clear span or 600 mm, whichever is less, for an end span with one end fixed and the other continuous, the effective span is:

- a) Average of support widths
- b) Centre-to-centre distance
- c) Clear span between supports
- d) Not defined

Answer: C

18. For imposed load (not fixed), the bending moment coefficient near the middle of the end span is:

- a) $+1/16$
- b) $-1/16$
- c) $+1/10$
- d) $-1/10$

Answer: C

19. What is the bending moment coefficient at the mid-span of an interior span for dead load and imposed load (fixed)?

- a) $+1/10$
- b) $+1/16$
- c) $-1/16$
- d) $+1/9$

Answer: B

20. For continuous beams, IS 456 suggests that (l_0) may be taken as:

- a) Full span
- b) $0.8 \times$ effective span
- c) $0.5 \times$ effective span
- d) $0.7 \times$ effective span

Answer: D

21. A continuous beam carries a dead load and live load of 25 kN/m over a span of 6 m. If the bending moment coefficient is $1/16$, the design span moment is:

- a) 45 kN·m
- b) 50 kN·m
- c) 56.25 kN·m
- d) 60 kN·m

Answer: C

22. A beam has a span of 5 m and carries a UDL of 18 kN/m. If the end support shear coefficient is 0.45, the support reaction is:

- a) 36 kN
- b) 40.5 kN
- c) 45 kN
- d) 50 kN

Answer: B

23. What is the effective flange width of a T-beam according to IS 456:2000?

- a) $(l_0/3 + b_w + 6D_f)$
- b) $(l_0/6 + b_w + 6D_f)$
- c) $(l_0/3 + b_w + 3D_f)$
- d) $(l_0/12 + b_w + 3D_f)$

Answer: B

24. An isolated T-beam has $l_0 = 6$ m, $b_w = 300$ mm and $D_f = 120$ mm. The effective flange width is:

- a) 1820 mm
- b) 2020 mm
- c) 2200 mm
- d) 2400 mm

Answer: B

25. An L-beam has $l_0 = 7.2$ m, $b_w = 300$ mm and $D_f = 150$ mm. The effective flange width is:

- a) 1250 mm
- b) 1350 mm
- c) 1450 mm
- d) 1550 mm

Answer: B

26. The transverse reinforcement in the flange of a T-beam should extend on each side of the web up to:

- a) l
- b) $l/4$
- c) $l/8$
- d) $l/3$

Answer: C

27. As per IS 456:2000, for a continuous slab/beam, the shear coefficient at the end support for dead load and imposed load (fixed) is:

- a) 0.4
- b) 0.45
- c) 0.5
- d) 0.6

Answer: A

28. In the T-beam formula, what is the maximum allowed value of (b_f) ?

- a) Any calculated value
- b) Twice the web width
- c) Should not exceed the actual flange width
- d) Equal to the effective span

Answer: C

29. What is the significance of the term $(d - D_f/2)$ in the flange moment?

- a) Distance to the centroid of the beam
- b) Total depth of the flange
- c) Distance to the neutral axis
- d) Lever arm of the flange compression force

Answer: D

30. Analysis of a continuous beam can be done by:

- a) Moment Distribution Method
- b) Clapeyron's Three Moment Theorem
- c) Slope-Deflection Method
- d) All of the above

Answer: D

UNIT – IV

1. The main reinforcement in a one-way slab is provided:

- a) In both directions
- b) Perpendicular to the shorter span
- c) Along the longer span
- d) Along the shorter span

Answer: D

2. Bending moment in a simply supported one-way slab under uniformly distributed load (UDL) is:

- a) $wL^2/8$
- b) $wL^2/12$
- c) $wL^2/16$
- d) $wL^2/10$

Answer: A

3. The main reinforcement in a one-way slab is generally placed:

- a) At the top
- b) At the bottom
- c) At the centre
- d) Along the edges

Answer: B

4. In a one-way slab, the distribution steel is provided to:

- a) Carry bending moment
- b) Resist torsion
- c) Control temperature and shrinkage stresses
- d) Provide shear resistance

Answer: C

5. The maximum spacing of main reinforcement in a one-way slab shall not exceed:

- a) $3d$ or 300 mm, whichever is less
- b) $3d$ or 450 mm, whichever is less
- c) $3d$ or 500 mm, whichever is less
- d) $3d$ or 250 mm, whichever is less

Answer: A

6. Slab thickness is generally governed by:

- a) Ultimate moment
- b) Deflection control
- c) Steel cost
- d) Dead load

Answer: B

7. Slabs are generally designed for:

- a) Dead load only
- b) Dead load + Live load + Floor finish load
- c) Dead load + Wind load
- d) Live load only

Answer: B

8. The development length in slab reinforcement is provided to:

- a) Avoid shear
- b) Ensure anchorage
- c) Prevent corrosion
- d) Reduce concrete cover

Answer: B

9. The minimum percentage of tension reinforcement for a slab (Fe415) as per IS 456:2000 is:

- a) 0.12%
- b) 0.15%
- c) 0.10%
- d) 0.25%

Answer: A

10. The effective span of a cantilever slab is:

- a) Clear span
- b) Clear span + effective depth
- c) Clear span + half the effective depth
- d) Centre-to-centre of supports

Answer: C

11. The span-to-depth ratio for a cantilever slab is:

- a) 20
- b) 26
- c) 7
- d) 35

Answer: C

12. For a slab of thickness 160 mm, the maximum diameter of reinforcement should not exceed:

- a) 16 mm
- b) 20 mm
- c) 24 mm
- d) 32 mm

Answer: B

13. Effective span of a simply supported one-way slab is:

- a) Clear span + effective depth
- b) Clear span + width of support
- c) Lesser of (clear span + effective depth) or centre-to-centre of supports
- d) Clear span only

Answer: C

14. A one-way slab has an effective depth of 120 mm. The maximum spacing of main bars is:

- a) 300 mm
- b) 360 mm
- c) 400 mm
- d) 450 mm

Answer: B

15. A 150 mm thick slab is reinforced with Fe415 bars. The minimum reinforcement required per metre width of the slab is:

- a) 150 mm²
- b) 180 mm²
- c) 200 mm²
- d) 225 mm²

Answer: B

16. Which of the following is a two-way slab?

- a) 2 m × 5 m
- b) 3 m × 7 m
- c) 4 m × 5 m
- d) 2 m × 6 m

Answer: C

17. The width of the middle strip in a two-way slab is taken as:

- a) The full width of the slab
- b) Half of the slab width
- c) 0.125 times the slab length
- d) 0.75 times the slab length

Answer: D

18. The edge strip and middle strip concept is used for designing:

- a) Cantilever slab

- b) One-way slab
- c) Two-way slab
- d) Continuous slab

Answer: C

19. In a two-way slab, torsional reinforcement is provided at:

- a) Edges
- b) Centre
- c) Corners
- d) Mid-span

Answer: C

20. The reinforcement provided at slab corners is mainly intended to resist:

- a) Flexure
- b) Compression
- c) Torsion
- d) Shear

Answer: C

21. For a simply supported two-way slab, the corners tend to:

- a) Lift upward
- b) Deflect more
- c) Remain at the same level
- d) Be restrained from lifting

Answer: A

22. The load carried by a two-way slab is transferred to:

- a) Two opposite supports only
- b) All four supporting beams
- c) One beam only
- d) Columns only

Answer: B

23. Moment coefficients for two-way slabs depend on:

- a) Area of slab
- b) Aspect ratio (L_y/L_x)
- c) Thickness only
- d) Live load

Answer: B

24. Which of the following pairs correctly expresses the bending moments in the shorter and longer spans of a two-way slab?

- a) $M_x = \alpha_x \times w \times L_x^2$; $M_y = \alpha_y \times w \times L_y^2$
- b) $M_x = \alpha_x \times w \times L_x^2$; $M_y = \alpha_y \times w \times L_x^2$
- c) $M_x = \alpha_x \times w \times L_y^2$; $M_y = \alpha_y \times w \times L_x^2$

d) $M_x = \alpha_x \times w \times L_y^2$; $M_y = \alpha_y \times w \times L_x^2$

Answer: B

25. The edge strip width of a two-way slab having a shorter span of 4 m is:

- a) 0.40 m
- b) 0.50 m
- c) 0.75 m
- d) 1.00 m

Answer: B

26. What is the span-to-overall depth ratio for control of deflection in a simply supported two-way slab with mild steel reinforcement?

- a) 40
- b) 20
- c) 26
- d) 35

Answer: D

27. A slab has dimensions 3 m × 7 m. The slab is classified as:

- a) One-way slab
- b) Two-way slab
- c) Cantilever slab
- d) Continuous slab

Answer: A

28. A simply supported slab has a clear span of 4.5 m, effective depth of 150 mm, and centre-to-centre distance of supports of 4.7 m. The effective span is:

- a) 4.50 m
- b) 4.65 m
- c) 4.70 m
- d) 4.80 m

Answer: B

29. A continuous one-way slab has an effective span of 5.2 m. The minimum effective depth is:

- a) 180 mm
- b) 200 mm
- c) 220 mm
- d) 250 mm

Answer: B

30. A simply supported two-way slab has a shorter span of 3.5 m. The minimum overall depth is:

- a) 100 mm
- b) 120 mm

- c) 150 mm
 - d) 180 mm
- Answer: A**

UNIT – 5

1. The minimum diameter of longitudinal bars used in columns shall be:
- a) 8 mm
 - b) 10 mm
 - c) 12 mm
 - d) 16 mm

Answer: C

2. Long columns fail due to:
- a) Buckling
 - b) Crushing
 - c) Bending
 - d) Torsion

Answer: A

3. The minimum area of longitudinal reinforcement in a column is:
- a) 0.6% of gross area
 - b) 0.8% of gross area
 - c) 1.0% of gross area
 - d) 1.2% of gross area

Answer: B

4. Effective length of a column depends on:
- a) Cross-section
 - b) Support condition
 - c) Load only
 - d) Slenderness ratio

Answer: B

5. Minimum cover for column reinforcement is:
- a) 20 mm
 - b) 30 mm
 - c) 40 mm
 - d) 50 mm

Answer: C

6. Which footing is preferred for two columns placed close together?
- a) Strip footing
 - b) Combined footing
 - c) Sloped footing

d) Mat footing

Answer: B

7. The footing is considered safe when:

- a) Shear $>$ Moment
- b) Soil pressure $\leq$ SBC
- c) Load $>$ Area
- d) Reinforcement is more

Answer: B

8. Maximum spacing of main reinforcement bars in footings as per IS 456:2000 should not exceed:

- a) 250 mm
- b) 150 mm
- c) 200 mm
- d) 300 mm

Answer: D

9. As per IS 456:2000, the minimum reinforcement in footing slabs using Mild Steel is:

- a) 0.12%
- b) 0.15%
- c) 0.20%
- d) 0.25%

Answer: B

10. The primary cause of bending moment in an isolated footing slab is:

- a) Downward load from the column
- b) Self-weight of the footing
- c) Lateral earth pressure
- d) Upward reaction from the soil

Answer: D

11. Minimum eccentricity for a column is given by:

- a) $L/300 + D/25$
- b) $L/400 + D/20$ or 20 mm, whichever is smaller
- c) $L/500 + D/30$ or 20 mm, whichever is smaller
- d) $L/600 + D/50$

Answer: B

12. Two-way shear is also known as:

- a) Flexural shear
- b) Diagonal shear
- c) Punching shear

d) Horizontal shear

Answer: C

13. What is the maximum compressive strain in concrete under axial compression as per IS 456:2000?

- a) 0.001
- b) 0.002
- c) 0.0035
- d) 0.004

Answer: B

14. The minimum edge thickness of an RCC footing should not be less than:

- a) 100 mm
- b) 150 mm
- c) 200 mm
- d) 250 mm

Answer: B

15. Punching shear in a footing is checked at a distance of:

- a) $d/2$ from the face of the column
- b) d from the face of the column
- c) $2d$ from the face of the column
- d) At the face of the column

Answer: A

16. A column has an effective length of 4.8 m and a least lateral dimension of 400 mm. The column is classified as:

- a) Long column
- b) Short column
- c) Pedestal
- d) Composite column

Answer: A

17. A square column of 300 mm $\times$ 300 mm is reinforced with 4 bars of 20 mm diameter. The percentage of steel is closest to:

- a) 0.8%
- b) 1.4%
- c) 2.2%
- d) 3.5%

Answer: B

18. Why are lateral ties closely spaced near the ends of a column?

- a) To increase cover
- b) To improve confinement and prevent buckling
- c) To reduce concrete volume

d) To reduce footing size

Answer: B

19. Two identical columns carry the same load. One is tied and the other is spirally reinforced. Which column generally has better ductility?

- a) Tied column
- b) Spiral column
- c) Both are identical
- d) Cannot be determined

Answer: B

20. A footing supports a 400 mm × 400 mm column. If the effective depth is 500 mm, punching shear is checked at:

- a) Column face
- b) 250 mm from the column face
- c) 500 mm from the column face
- d) Footing edge

Answer: B

21. A column has an unsupported length of 3.6 m and both ends are fixed. The effective length is:

- a) 2.34 m
- b) 2.70 m
- c) 3.60 m
- d) 7.20 m

Answer: A

22. A column has an effective length of 4.2 m and a least lateral dimension of 385 mm. The column is classified as:

- a) Short column
- b) Long column
- c) Pedestal
- d) Spiral column

Answer: A

23. A footing carry 1200 kN on an area of 4 m². If the Safe Bearing Capacity (SBC) is 350 kN/m², the footing is:

- a) Unsafe
- b) Safe
- c) Needs shear reinforcement only
- d) Needs combined footing

Answer: B

24. A column has an unsupported length of 3 m and a least lateral dimension of 300 mm. The minimum eccentricity is:

- a) 15 mm
- b) 18 mm
- c) 20 mm
- d) 25 mm

Answer: C

25. As per IS 456:2000, the minimum depth of footing below ground level is:

- a) 100 mm
- b) 200 mm
- c) 300 mm
- d) 500 mm

Answer: D

26. Which footing is preferred for two columns placed close together?

- a) Strip footing
- b) Combined footing
- c) Sloped footing
- d) Pad footing

Answer: B

27. Raft footing is preferred when:

- a) Soil has low bearing capacity
- b) Column loads are very light
- c) Construction is on rocky strata
- d) A single isolated column is present

Answer: A

28. A footing requires an effective cover of 60 mm. If 20 mm diameter bars are used, the clear cover should be:

- a) 40 mm
- b) 50 mm
- c) 60 mm
- d) 70 mm

Answer: B

29. A column is located very close to the property boundary. Which footing is generally adopted?

- a) Isolated footing
- b) Combined footing
- c) Strap footing
- d) Raft footing

Answer: C

30. A square footing measures 2.5 m × 2.5 m with an overall depth of 500 mm. Using Fe415 steel, the minimum reinforcement required in each direction is:

- a) 1200 mm²
- b) 1350 mm²
- c) 1500 mm²
- d) 1800 mm²

Answer: C

Part B — 10 mark(s) each

Unit I

1. A singly reinforced rectangular beam has:

- $b = 300 \text{ mm}$
- $d = 500 \text{ mm}$
- $A_{st} = 1500 \text{ mm}^2$
- Concrete grade = M20
- Steel grade = Fe415

Calculate the moment of resistance of the section.

2. A reinforced concrete simply supported beam of size 300mm x 450mm (effective) when M20 grade concrete and Fe415 grade steel are used. Determine the area of tension steel required for a balanced section. Also find the limiting value of ultimate moment of resistance of the section.
3. Design a singly reinforced rectangular beam to carry an UDL of 22kN/m (Inclusive of self-weight) over an effective span of 6m for the limit state of collapse in flexure using M20 grade concrete and Fe415 grade steel.
4. A cantilever beam is subjected to a factored bending moment of 100 kNm. The breadth of the beam is 250 mm. Determine the effective depth and area of tension steel required for the beam if M25 grade concrete and Fe415 grade steel are used.
5. Design a singly reinforced rectangular beam to carry a factored bending moment of 120 kNm using M20 grade concrete and Fe415 grade steel.
 - a. Determine the effective depth of the beam. **(4 Marks)**
 - b. Calculate the area of tension reinforcement required. **(4 Marks)**
 - c. Sketch the cross-section showing the reinforcement details. **(2 Marks)**

Unit II

1. A simply supported rectangular beam has an effective depth of 600mm and breadth of 300mm. The beam is reinforced with 3 bars of 20mm as tension reinforcement at the support. The beam is subjected to a factored shear force of 180kN at the support. Check the shear stress and design shear

reinforcement. M20 grade concrete and Fe 250 steel are used. Use 8mm diameter 2-legged stirrups of Fe 415.

2. A doubly reinforced rectangular cantilever beam is subjected to a design shear of 250 kN. The breadth and effective depth of the beam are 305 mm and 610 mm, which are uniform throughout. The tension zone is reinforced with 5 nos. of 25 mm dia bars and concrete grade is M25. Determine the spacing of 8mm dia 2-legged stirrups of Fe 415 grade steel required near the support section.
3. A simply supported RC rectangular beam of 250mm x 510mm overall size carries an/udl of 15 kN/m (inclusive of its self-weight) over an effective span of 5.5m. It is reinforced with 4 Number 20mm & mild steel bars in tension with a clear cover of 25mm throughout its length. The concrete is M20 grade. Design the shear reinforcement in the form of vertical stirrups for the maximum shear force using 8mm & 2-legged stirrups, mild steel bars.
4. Explain the planning of a dog-legged staircase with a neat sketch.
5. Explain the classification of staircases.
 - a. Classify staircases according to geometry and shape. (5 Marks)
 - b. Classify staircases according to structural behaviour. (5 Marks)

Unit III

1. A 'T' beam section has a flange of 1280 mm x 100 mm, effective depth of 700 mm and breadth of web of 280 mm. It is reinforced with 5 nos. of 25 mm diameter Fe415 grade steel bars in the tension zone. M20 grade concrete is used. Determine the moment of resistance of the section at the limit state of collapse.
2. A R.C T-beam section has a flange of 1600mm x 100mm size and a web of 300mm x 650mm size (overall). It has to resist a design moment of 800 kNm. Use M25 grade concrete and Fe500 grade steel bars. Design the tension reinforcement for the beam.
3. Design a RC continuous beam has three equal spans of 5 meters each. The beam has a rectangular cross-section of 300 mm in width and 650 mm in overall depth. It is subjected to a total factored udl of 50 kN/m along its entire length. Use M20 grade concrete and Fe 415 grade steel.
4. A continuous rectangular beam of overall size 230mm x 460 mm is supported by 230 mm wide brick masonry wall at a clear interval of 4.2m. The beam has to carry a dead load of 24kN/m excluding its self-weight and an imposed load of 16kN/m. M 20 grade concrete and Fe415 grade steel are used. Design the reinforcement for the interior support section by limit state method of flexure.

5. Explain the Neutral Axis and Moment of Resistance of a singly reinforced T-beam.
 - a. Draw the cross-section of a T-beam and label its parts. **(2 Marks)**
 - b. Explain the case when the neutral axis lies within the flange. **(4 Marks)**
 - c. Explain the case when the neutral axis lies within the web. **(4 Marks)**

Unit IV

1. Design a simply supported roof slab for a hall of 4m x 12m clear size using M20 grade concrete and Fe415 grade steel. The width of walls all around is 230mm. Access is provided to the roof. The weight of weathering course is 1.5 kN/m^2 .
2. Design a RC sunshade, with a clear projection of 610mm from lintel, to carry an imposed load of 750 N/m^2 , using M20 grade concrete and mild steel reinforcement by limit state method for flexure.
3. Design a two-way slab to be supported by brick walls of 200mm width on all four sides. The clear dimension of the room is 2m x 3m. Assume the total design load including self-weight of the slab is 5.74 kN/m^2 , grades of concrete and steel are M15 and Fe 250 respectively.
4. Design a roof slab for a pump house of size 3.0m x 4.0m (effective span). The slab is supported on all its four sides by 230mm wall thickness. The edges of the slab are discontinuous and the corners are prevented from lifting. Access is to be provided to the roof. The weight of weathering course over the slab is 2 kN/m^2 . Use M20 grade concrete and Fe 415 grade steel.
5. Explain the design considerations of reinforced concrete slabs.
 - a. Explain the classification of slabs with suitable sketches. **(3 Marks)**
 - b. State the checks for shear and stiffness to be carried out in slab design. **(3 Marks)**
 - c. Determine the effective span of a simply supported slab and state the reinforcement requirements (minimum reinforcement, maximum spacing and nominal cover) as per IS 456:2000. **(4 Marks)**

Unit V

1. A 400 mm x 300 mm RC column, 4m long effectively held in position at both ends and restrained against rotation at one end is required to carry an axial load of 1140 kN. Design the column with lateral ties. M20 concrete and Fe415 steel are used.
2. Design a short circular column with circular rings using concrete grade M20 and steel grade Fe 415 to carry an axial load of 700kN. The effective length of the column is 3.5m. Mild steel bars may be used for transverse

reinforcement. Ignore minimum eccentricity.

3. A RC Column, 300mm square in size carries an axial load of 1000kN including its self-weight. SBC of soil is 90kN/m^2 . M20 grade concrete and Fe250 grade mild steel reinforcement are to be used. Determine the size and thickness required for the square base (with uniform depth) for the limit state of collapse in flexure.
4. A Rectangular column 400mm x 600mm carries an axial load of 700kN. Design a rectangular footing of uniform thickness if safe bearing capacity of soil is 100kN/m^2 Use M 20 and Fe 250.
5. Explain the design considerations of isolated R.C.C. footings.
 - a. Classify the types of R.C.C. footings with neat sketches. **(3 Marks)**
 - b. State the basic requirements of a good footing. **(3 Marks)**
 - c. Explain the critical sections for bending moment, one-way shear and punching shear in an isolated footing. **(4 Marks)**