1. The horizontal distance between parallel main reinforcement bars shall not be more than _____the effective depth of solid slab.

A. Two times
B. Three times
C. Four times
D. Five times

Ans. B

Sol. As per clause 26.3.3 b) 1). The maximum spacing of reinforcement in slabs is **3d or 300mm**(minimum of both).

2. If the span to effective depth ration of a simply supported beam, for span upto 10 m, does not exceed_____, the vertical deflection limits may generally be satisfied.

A. 30
B. 35
C. 20
D. 26

Ans. C

Sol. For Span ≤ 10m

Effective depth d = $\frac{span}{A}$

For cantilever A = 7

Simply supported beam = 20

Continuous beam = 26

3. A RC column 4 m long and 400 mm in dia is reinforced by 8 bar of the 20 mm dia, find the safe load, the column can carry $\sigma_{cc} = 4N/mm^2$, $\sigma_{sc} = 130N/mm^2$,

A. 800 kN
B. 810 kN
C. 819.33 kN
D. 810.55 kN

Ans. C

Sol.

$$A_{sc} = 8 \times \frac{\pi}{4} \times 20^2 = 2513.23 mm^2$$

$$A_c = \frac{\pi}{4} \times 400^2 - 2513.27 = 123150.43 mm^2$$

$$P = \sigma_{cc} A_c + \sigma_{sc} A_{sc} = 4 \times A_c + 130 A_{sc}$$

$$P = 4 \times 123150.43 + 130 \times 2513.27$$

$$P = 819.33 kN$$

4. The bond stress acting parallel to the reinforcement on the interface between bar and concrete are:

A. Shear stress
B. Local stress
C. Flexural stress
D. Bearing stress

Ans. A

Sol. Bond stress is defined as the shear force per unit of nominal surface area of reinforcing bar i.e. shear stress, acting parallel to the bar on the interface between the bars and the surrounding concrete.

5. While designing combined footing, the resultant of the column loads passes, through the centre of gravity of the footing slab such that the net soil pressure obtained is

A. Parabolic B. Trapezoidal

C. Uniform D. Non uniform

Ans. C

Sol. It is desirable to design combined footing so that the controlled of the footing area coincides with the resultant of the two column loads. This produces uniform bearing pressure over the entire area and forestalls a tendency for the footing to tilt.

6. Minimum shear reinforcement in beams is provided in the form of stirrups

A. to resist extra shear force due to live load

B. to resist the effect of shrinkage of concrete

C. to resist principal tension

D. to resist shear cracks at the bottom of beam

Ans. D

Sol. The provision of nominal web reinforcement restrains the growth of shear cracks at the bottom of beam.

7. According to IS : 456-200, side-face reinforcement should be provided when depth of web of a beam exceeds

A. 650 mm B. 700 mm

C. 725 mm D. 750 mm

Ans. D

Sol. Clause 26.5.1.3, side-face reinforcement should be provided if the depth of bean exceeds 750 mm.

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. none of the above

Ans. C

Sol. The spiral reinforcement is designed so as to increase the capacity of core by maintaining the column yield capacity when shell spalls off. Sprial reinforce-ment provides confinement to the core from all directions and hence the core is under triaxial compression in axially loaded columns

9. In a pre-stressed member, it is advisable to use

A. low-strength concrete

B. high-strength concrete

C. high-strength concrete and high-tension steel

D. high-strength concrete and low-tension steel

Ans. C

Sol. To with stand high stresses in prestressed concrete members high grade material are required.

10. If any tension reinforcement in an RC beam attains its yield stress during loading before the concrete in the compression zone fails due to crushing, the beam is said to be

A. under-reinforced
B. over-reinforced
C. balanced
D. non-homogeneous

Ans. A

Sol. In under reinforced section steel yields prior to crushing of concrete.

11. Calculate the development length of 20 mm diameter Fe415 HYSD steel bar if T_{bd} = 1.4 for plain reinforcement.

A. 1288.30 mm
B. 805.19 mm
C. 1108.67 mm
D. 898.23 mm

Ans. B

Sol. T_{bd} = 1.4 for plain R/F

T_{bd} = 1.6 × 1.4 for Deformed R/F

$$L_d = \frac{\phi \sigma_{st}}{4T_{bd}}$$

$$= \frac{20 \times 0.87 \times 415}{4 \times 1.6 \times 1.4} = 805.19 \text{ mm}$$

12. As per IS (Indian Standard) specifications, the minimum number of longitudinal bars provided in a column shall be _____ in rectangular columns and _____ in circular columns.

A. 6, 4
B. 4, 6
C. 4, 8
D. 6, 8

Ans. B

Sol. To fulfill the reversal condition of BM minimum no of bars in rectangular is taken as 4, in circular 6 and in octagon 8.

13. The maximum diameter of the reinforcement bars in R.C.C. slabs is _____.

A. 20 mm
B. 16 mm
C. Span/100
D. Thickness of slab/8

Ans. D

Sol. The maximum diameter of the reinforcement bars in R.C.C. slabs is Thickness of slab/8

14. The shear resistance in a R.C. member :

A. Increases with increase in the grade of concrete
B. Decreases with increase in the grade of concrete
C. Increases with grade of longitudinal tensile reinforcement
D. None of the above

Ans. A

Sol. Higher grade of concrete has higher characteristic strength which in turn results in
(i) higher tensile strength

(ii) greater dowel shear resistance,

(iii) greater aggregate interlock capacity and

(iv) greater concrete strength in compression zone.

Hence shear resistance increases with the increase in the grade of concrete.

15. Reinforced concrete beam curved in plans is designed for :

A. Bending Moment B. Shear Force

C. Torsion D. All of the above

Ans. D

Sol. RC beam curved in plane is designed for bending moment, shear force and torsion.

16. In limit state approach, spacing of main reinforcement controls primarily :

A. Collapse B. Deflection

C. Cracking D. Durability

Ans. C

Sol. In limit state approach spacing of main reinforcement controls primarily cracking. Because the crack widths must be within acceptable limits under service conditions. Moreover, there should not be any free path for propagation of cracks without being traversed by reinforcement. This is achieved by limiting maximum spacing of reinforcement and minimum amount of reinforcement.

17. Bulking:

A. Decreases with fineness of aggregates B. Increases with fineness of aggregates

C. Is not related to fineness of aggregates D. Is higher for coarse aggregates

Ans. B

Sol. Bulking Increases with fineness of aggregates and is negligible in case of coarse aggregates. It has great importance in case of fine aggregates or sand.

18. For two-way slab, the amount of minimum reinforcement in either direction for Fe415 is :

A. shall not be less than 0.15 per cent of total cross-sectional area

B. shall not be less than 0.2 per cent of total cross-sectional area

C. shall not be less than 0.12 per cent of total cross-sectional area

D. shall not be less than 0.9 per cent of total cross-sectional area

Ans. C

Sol. As per IS 456 : 2000, clause 26.2.5.1, both for one and two way two slabs, amount of minimum reinforcement in either direction shall not be less than 0.15 and 0.12 per cent of total cross-sectional area for Fe 250 and Fe 415/500 respectively.

19. Lap length in compression shall not be less than

A. 20 D B. 24 D

C. 30 D D. 15 D

Ans. B

Sol. As per IS 456 : 2000, clause 26.2.5.1,

The lap length in compression shall be equivalent to the development length in compression computed but not less than 24D

20. What is the adoptable maximum spacing between vertical stirrups in an RCC beam of rectangular cross section having an effective depth of 300mm?

A. 300mm B. 275mm

C. 250 mm D. 225 mm

Ans. D

Sol. Spacing between vertical stirrups should be minimum of

$-0.75d = 0.75 \times 300$

= 225 mm,

So adaptable maximum spacing is 225 mm.

21. Unequal top and bottom reinforcement in a reinforced concrete section leads to

A. Creep deflection B. Shrinkage deflection

C. Long term deflection D. Large defection

Ans. B

Sol. The shrinkage deflection depends on the Relative amount of tension and compression reinforcement

22. 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

Ans. C

Sol. Acc.to IS : 456, the minimum number of longitudinal bars provided in a column shall be 4 in rectangular column and 6 in circular column.

23. The codal provision recommends minimum shear reinforcement in the form of stirrups in the beam

1. To cater for any torsion in the beam section
2. To improve ductility of the cross section
3. To improve dowel action of longitudinal tension bar.

Select the correct answer using the codes given below:

A. 1,2 and 3 B. 2and3

C. Only 1 D. Only 2

Ans. B

Sol. The provisional of nominal web Reinforcement restrains the growth of inclined shear cracks, improves the dowel action of the longitudinal tension bars, introduces ductility in shear and provides a warning of the impending failure.

24. Torsion resisting capacity of a given RC section

A. decreases with decrease in stirrup spacing

B. decreases with increase in longitudinal bars

C. does not depend upon stirrup and longitudinal steels

D. increases with the increase in stirrup and longitudinal steel

Ans. D

Sol. As the area of longitudinal and transverse reinforcement increases and hence the torsion resistance capacity of the section increases. To resist torsion section reinforcement must consist of closely spaced stirrups and longitudinal bars.

25. In beams the maximum area of the reinforcement in tension reinforcement shall not exceed

A. 0.04 bD B. 0.02 bD

C. 0.03 bD D. 0.01 bD

Ans. A

Sol. As per IS 456:2000, clause 26.5.1.1 (b)

26. face reinforcement is provided in RCC beams when the depth exceeds

A. 450mm B. 750mm

C. 1000mm D. 1250mm

Ans. B

Sol. As per IS 456:2OOO, clause 26.5.1.3, Where the depth of the web in a beam exceeds 750 mm, side face reinforcement shall be provided along the two faces. The total area of such reinforcement shall be not less than 0.1 percent of the web area and shall be distributed equally on two faces at a spacing not exceeding 300mm or web thickness whichever is less.

27. What is the anchorage value of a standard hook of a reinforcement bar of diameter D?

A. 4D B. 8D

C. 12D D. 16D

Ans. D

Sol. For a bend of 45^{o} , anchorage value is takend is 4φ.

Since in a hook change of angel is 180^{0}.

Anchorage value of a standard u-type hook is equal to 16φ where φ diameter of the bar.

28. Flexural collapse in over reinforced beams is due to

A. primary compression failure B. secondary compression failure

C. primary tension failure D. bond failure

Ans. B

Sol. The concrete fails in compression before the steel reaches its yield point when subjected to failure and this type of failure is called secondary compression failure. Primary compression failure is the failure due to application of axial compressive load.

29. Then tensile strength of concrete to be used in the design of reinforced concrete members is _____.

A. $0.2\,f_{ck}$ B. $0.1\,f_{ck}$

C. $0.7\sqrt{f_{ck}}$ D. 0

Ans. C

Sol. As per IS 456:2000

Then tensile strength of concrete to be used in the design of reinforced concrete members is $0.7\sqrt{f_{ck}}$ Or about to 10% to 15% of compressive strength.

30. Percentage of steel for balanced design of a singly reinforced rectangular section by limit state method depends on

A) Characteristic strength of concrete

B) Yield strength of steel

C) Modulus of elasticity of steel

D) Geometry of the section

A. Only B B. A, B and D

C. B, C and D D. A, B and C

Ans. B

Sol. Percentage of steel for balanced design(steel and concrete reach the limit state simultaneously) of a singly reinforced rectangular section by limit state method depends on Characteristic strength of concrete,

Yield strength of steel and geometry of section

31. If the size of a column is reduced above the floor, the main bars of the columns _____.

A. continues up

B. bend inwards at the floor level

C. stops just below the floor level and separates lap bars provided

D. All options are correct

Ans. D

Sol. If the size of a column is reduced above the floor, the main bars of the columns, continues up, bend inwards at the floor level, stops just below the floor level and separates lap bars provided.

32. While estimating a reinforced cement structure the omitted cover of concrete is assumed _____.

A. at the end of reinforcing bar, not less than 25 mm or twice the diameter of the bar

B. in thin slabs, 12 mm minimum or diameter of the bar whichever is more

C. for reinforcing longitudinal bar in a beam 25 mm minimum or diameter of the largest bar which is more

D. All options are correct

Ans. D

Sol. While estimating a reinforced cement structure the omitted cover of concrete is assumed, at the end of reinforcing bar, not less than 25 mm or twice the diameter of the bar, in thin slabs, 12 mm minimum or diameter of the bar whichever is more, for reinforcing longitudinal bar in a beam 25 mm minimum or diameter of the largest bar which is more.

33. In bending, the maximum strain in concrete at the outer-most compression fibre is taken as _____.

A. 0.002 B. 0.0025

C. 0.0035 D. None of these

Ans. C

Sol. Beams are tension members and it is assumed that Ultimate limit state of bending failure is deemed to have been reached when the strain in concrete at the extreme bending compression fiber reaches 0.0035. This is because it is assumed that steel yields first than concrete

34. Diagonal tension in beam _____.

A. is maximum at neutral axis

B. decreases below the neutral axis and increases above the neutral axis

C. increases below the neutral axis and decreases above the neutral axis

D. remains the same in both above and below the neutral axis

Ans. C

Sol. Shear failure of reinforced concrete, more properly called "diagonal tension failure" is one example. If a beam without properly designed shear reinforcement is overloaded to failure, shear col- lapse is likely to occur suddenly with no advance warning (brittle failure).

35. In limit state approach, spacing of main reinforcement controls primarily

A. collapse
B. durability
C. deflection
D. cracking

Ans. D

Sol. The code specifies minimum and maximum limits for the spacing between parallel reinforcing bars in a layer.

The maximum limits are specified for bars in tension for the purpose of controlling crack – widths and improving bond.

36. If σ_a is the stress in bar and τ_{bd} is the design bond stress, then the development length of a bar of diameter φ is given by

A. $\frac{4\phi\sigma_a}{\tau_{bd}}$
B. $\frac{\phi\sigma_a}{4\tau_{bd}}$
C. $\frac{2\phi\sigma_a}{3\tau_{bd}}$
D. $\frac{\phi\sigma_b}{3\tau_{bd}}$

Ans. B

Sol. to calculate tension or compression in any bar at any section by an appropriate development length or end anchorage

Development length L_d is given by,

$L_d = \frac{\phi\sigma_a}{4\tau_{bd}}$

Where,

Φ = nominal diameter of bar

σ = shear in bar at the section considered as design load

τ_{bd} = design bond stress

37. For simply supported beams, the allowable deflection shall not exceed

A. l/325 of span
B. l/350 of span
C. l/375 of span
D. l/400 of span

Ans. B

Sol. for simply supported,

For the design of beam as per IS 456,

The maximum allowable deflection = span/350 or 20 mm whichever is less.

38. As per IS 456, the effective length of cantilever shall be taken as

A. clear span
B. clear span + effective depth/2
C. clear span + effective depth
D. clear span + effective width

Ans. B

Sol. as per IS 456, (Page 35- 22.2(c))

The effective length of the cantilever,

L_{eff} = clear span + effective depth/2

39. Minimum percentage of tension steel in an RCC beam for Fe 500 steel is

A. 0.12
B. 0.17
C. 0.22
D. 0.80

Ans. B

Sol. minimum reinforcement in tension member,

$A_{st}/bd = .85/f_y$

So, $A_{st} = .85/500 \times bd = .0017bd = .17\%$ of bd.

40. Minimum spacing between horizontal parallel reinforcement of different sizes should not be less than _____.

A. one diameter of thinner bar

B. one diameter of thicker bar

C. sum of the diameters of thinner and thicker bars

D. twice the diameter of thinner bar

Ans. B

Sol. Minimum Distance Between Individual Bars main reinforcing bars shall usually be not-less than the greatest of the following:

1. The diameter of the bar if the diameter are equal,

2. The diameter of the larger bar if the diameters are unequal, and

3. 5 mm more than the nominal maximum size of coarse aggregate.

41. According to Whitney's theory, the maximum depth of concrete stress block in a balanced RCC beam section of depth 'd' is _____.

A. 0.3 d B. 0.43 d

C. 0.5 d D. 0.53 d

Ans. D

Sol. for balanced R.C.C beam

If we use mild steel then for f_y=250

$X_{u,max}/d = .53$

$X_{u,max} = .53d$

42. The main reinforcement of a RC slab consists of 10 mm bars at 10 cm spacing. If it is desired to replace 10 mm bars by 12 mm bars, then the spacing of 12 mm bars should be _____.

A. 12cm B. 14cm

C. 14.40 cm D. 16 cm

Ans. C

Sol. spacing of reinforcement is directly proportional to the area of reinforcement.

So, $s_1/s_2 = d_1^2/d_2^2$

$10/s_2 = 10^2/12^2$

So, s_2 = 14.4 cm.

43. The span to depth ratio limit is specified in IS: 456 – 2000 for the reinforced concreted beams, in order to ensure that the:

A. shear failure is avoided

B. deflection of the beam is below a limiting value

C. stress in the tension reinforcement is less than the allowable value

D. tensile crack width is below a limit

Ans. B

Sol. The vertical deflection limit may generally be satisfied if

(a) Basic span to effective depth ratio for span upto 10m is

$$\frac{span}{effective\ depth}$$

Types of Beams:

For cantilever = 7

For simply supported = 20

For continuous = 26

44. The total length of a cranked bar through a distance (d) at 45^{O} in case of a beam of effective length L and depth (d) is?

A. L – 2 x 0.42 d

B. L + 0.42 d

C. L + 2 x 0.42 d

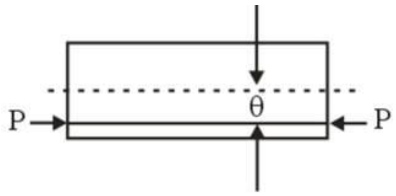
D. L – 0.42 d

Ans. C

Sol. length of bent up bar = length of straight bar + 2 * (Additional length due to inclination)

= {L-2*cover+2*9*dia of bar} + 2*0.414*d

45.



A tendon of rectangular pre-stress beam having cross-sectional area A is subjected to eccentric prestressing force P as shown in above fig. The stress at the top fiber is

A. P/A - Pe/Z

B. P/A + Pe/Z

C. -P/A + Pe/Z

D. None

Ans. A

Sol. stress at top fibre is : P/A - Pe/Z

: stress at bottom fibre is : P/A + Pe/Z

46. Which IS code gives details regarding p(H) water to be used in concrete?

A. IS 456

B. IS 383

C. IS 565

D. IS 3012

Ans. A

Sol. According to IS 456:

Water is one of the most important elements in construction and is required for the preparation of mortar, mixing of cement concrete and for curing work etc.

47. The design of a RC section as over reinforced is undesirable because :

A. It undergoes high strain
B. It fails suddenly
C. It consumes more concrete
D. It consumes more steel

Ans. B

Sol. When the section is over-reinforced, concrete reaches its maximum permissible value prior to steel. In over-reinforced section N.A. depth is large hence, strain across the section remains low. Consequently, the curvature, deflection and crack width also remains low. Thus failure is sudden. As there is no significant warning before failure, IS code does not allow over-reinforced section design.

48. A simply supported rectangular beam of span 30 m is subjected to UDL. 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. 3.0 m
B. 3.5 m
C. 4.0 m
D. 4.5 m

Ans. D

Sol. For simply supported beam

span to effective depth ratio(net) =20 X (10/span) X [modification factor for tension & compression reinforcement]

span to effective depth ratio(net) =20 X (10/30) X [0.9 x 1.1]

span to effective depth ratio(net) = 6.6

effective depth = span/6.6

Effective depth = 30/6.6=4.5m

Min. effective depth required = 4.5 *m*

49. The effective span, of cantilever slab at the end of a continuous slab is,

A. Clear span + effective depth of the slab
B. Clear Span + half of the effective depth of the slab
C. Length upto the centre of the support
D. Length up to the face of the support + half of the width of support

Ans. D

Sol. As per IS 456:2000, clause 22.2,

The effective span, of cantilever slab at the end of a continuous slab is equal to **length upto the centre of the support (L + W/2)**

W= Width of support

50. The critical section for shear is at a distance of from the periphery of the column, perpendicular to the plane of the slab where d is the effective depth of the section.

A. d/3
B. d/2
C. 0.7d
D. 0.6d

Ans. B

Sol. As per Is code 456:2000, clause 31.6.1, the effective depth of the section is d/2

51. A reinforced cantilever beam of span 4 m has a cross section of 150x500 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 requirements of deflection and lateral stability

Ans. C

Sol. Lateral stability-

For cantilever beam, span≤25b (it should be satisfied)

4m≤25×0.150m

=3.75

4>3.75

so, it will fail.

- For the control of vertical deflection-

For cantilever beam $(l/d)_{basic} \leq 7$

Here, $(l/d)_{provided} = 4000/500 = 8$

should be less than $(l/d)_{max}$.

So, it will also fail.(not satisfying the condition)

52. The floor slab of a building is supported on reinforced cement floor beams. The ratio of the end and intermediate spans is kept at _____.

A. 0.7 B. 0.8

C. 0.9 D. 0.6

Ans. C

Sol. The floor slab of a building is supported on reinforced cement floor beams. The ratio of the end and intermediate spans is kept at 0.9.

53. Partial safety for concrete and steel are 1.5 and 1.15 respectively, because _____.

A. Concrete is heterogeneous while steel is homogeneous

B. The control on the quality of concrete is not as good as that of steel

C. Concrete is weak in tension

D. Voids in concrete are 0.5% while those in steel are 0.15%

Ans. B

Sol. Partial safety for concrete and steel are 1.5 and 1.15 respectively, because control on the quality of concrete is not as good as that of steel.

54. Which one of the following statements is correct?

A. Shear cracks start due to high diagonal tension in case of beams with their webs and high pre-stressing force.

B. Shear design for a pre-stressed concrete beam is based on elastic theory

C. In the zone where bending moment is dominant and shear is insignificant, cracks occur at 20^o to 30^o.

D. After diagonal cracking, the mechanics of shear transfer in a pre-stressed concrete member is very much different from that in reinforced concrete members.

Ans. B

Sol. Shear cracks is not due to high pre-stressing force, Shear design for a pre-stressed concrete beam is based on elastic theory.

55. For avoiding the limit state of collapse, the safety of R.C. structures is checked for appropriate combinations of dead load (DL), imposed load or live load (IL), wind load (WL) and earthquake load (EL). Which of the following load combinations is **NOT** considered ?

A. 0.9 DL + 1.5 WL
B. 1.5 DL + 1.5 WL
C. 1.5 DL + 1.5 WL + 1.5 EL
D. 1.2 DL + 1.2 LL + 1.2 WL

Ans. C

Sol. Partial safety factors for load under limit stage of collapse.

Load Combination	DL	LL	WL
DL+LL	1.5	1.5	---
DL+WL	1.5	---	1.5
DL+WL	0.9	---	1.5
DL+LL+WL	1.2	1.2	1.2

56. The permissible value of span/depth ratio will be the highest in the case of

A. a simply supported beam
B. a cantilever beam
C. a continuous beam
D. it will be same for all cases

Ans. C

Sol. As per IS 456: 2000

Span/ depth ratios and modificati on factors Sl. No.	Items	Cantilever	Simply supported	Continuous
1	Basic values of span to effective depth ratio for spans up to 10 m	7	20	26
2	Modification factors for spans > 10 m	Not applicable as deflection calculations are to be done.	Multiply values of row 1 by 10/span in meters.	
3	Modification factors depending on area and stress of steel	Multiply values of row 1 or 2 with the modification factor from Fig.4 of IS 456.		
4	Modification factors depending as area of compression steel	Further multiply the earlier respective value with that obtained from Fig.5 of IS 456.		
5	Modification factors for flanged beams	(i) Modify values of row 1 or 2 as per Fig.6 of IS 456. (ii) Further modify as per row 3 and/or 4 where		

57. Minimum cement content required for M 35 grade of concrete for very severe exposure condition as per IS 456 -2000 is ------ kg/m^3

A. 300
B. 320
C. 340
D. 360

Ans. C

Sol. As per IS 456: 2000

Sl. No.	Environmental Exposure Condition	Reinforced Concrete		
		Minimum Cement Content (kg/m3)	Maximum Free Water-Cement Ratio	Minimum Grade of Concrete
1	Mild	300	0.55	M20
2	Moderate	300	0.50	M25
3	Severe	320	0.45	M30
4	Very Severe	340	0.45	M35
5	Extreme	360		

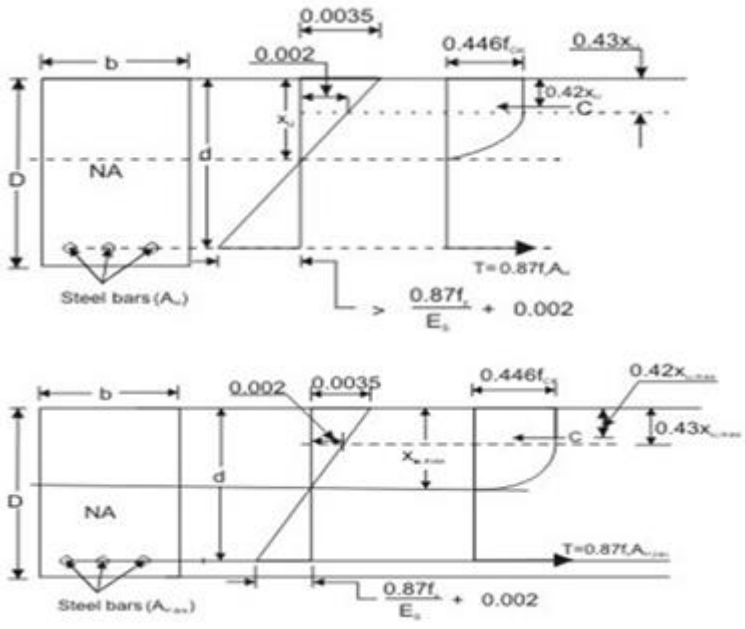
58. As per IS 456-2000; in the limit state design of a flexural member, the strain in reinforcing bar under tension at ultimate state should not be less than

A. $\frac{f_y}{E_x}$ B. $\frac{f_y}{E_x}+0.002$

C. $\frac{f_y}{1.15E_x}$ D. $\frac{f_y}{1.15E_x}+0.002$

Ans. D

Sol. As per IS code: 456-2000



59. The maximum shear stress in a rectangular beam is_____ times of average shear stress

A. 15 B. 1.25

C. 1.5 D. 1.75

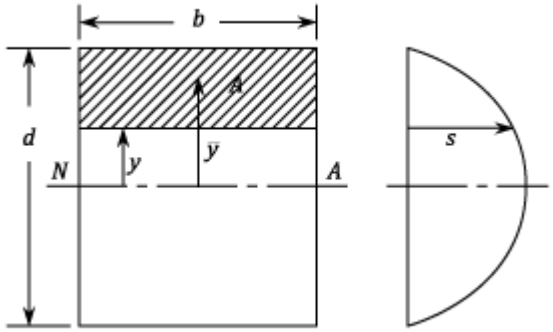
Ans. C

Sol. For Rectangular Sections.

For a rectangular section at any distance y from the Neutral Axis :

$$A = b\left(\frac{d}{2} - y\right)$$

$$bary = \frac{1}{2}\left(\frac{d}{2} + y\right) \text{ and } z = b$$



Substituting in equation

$$s = \left(\frac{\delta M}{\delta x}\right) \frac{A\,\bar{y}}{z\,I} = F \cdot \frac{A\bar{y}}{z\,I}$$

and putting

$$I = \frac{b\,d^3}{12}$$

$$s = \frac{F(d/2 - y)(d/2 + y)}{b \times (b\,d^3/12) \times 2}$$

$$\therefore \qquad s = \left(\frac{6\,F}{b\,d^3}\right)\left(\frac{d^2}{4} - y^2\right)$$

This shows that there is a parabolic variation of Shear Stress with y. The maximum Shear Force occurs at the Neutral Axis and is given by:

$$\hat{s} = \frac{3\,F}{2\,b\,d}$$

If $\frac{F}{bd}$ is called the Mean Stress then:

$$\hat{s} = 1.5 \times s_{mean}$$

60. In the given statements, how many statements are CORRECT?

Statement I:

The maximum spacing of vertical shear stirrups should not exceed 3/4 d or 300 mm.

Statement II:

The development length L_d as per IS-456:2000 for **deformed** bar is given by

$L_d = \frac{\phi\sigma_s}{4\tau_{bd}}$, where is τ_{bd} design bond stress in LSM for plain bars in tension.

Statement III:

The maximum size of reinforcement bar that can be used for 75 mm thick RCC slab is 8 mm.

Statement IV:

The minimum eccentricity for which an axially loaded column (350 mm x 350 mm) size with effective length of 3 m is 20 mm.

A. 3 B. 2

C. 1 D. 4

Ans. A

Sol. (i). The maximum spacing of vertical shear stirrups should not exceed $\frac{3}{4}d$ or 300 mm.

(ii). For deformed bar,

$$L_d = \frac{\phi\sigma_s}{4(1.6\tau_{bd})} = \frac{\phi\sigma_c}{6.4\tau_{bd}}$$

(iii). The diameter of bar shall not exceed one – eight of total thickness of slab.

Maximum size = $\frac{75}{8} = 9.375\,mm$

So, the diameter of bar will be 8 mm.

(iv). $e_{min} = \frac{L}{500} + \frac{B}{30}$ or 20 mm whichever is more = 17.67 mm or 20 mm

61. According to the concept of Limit State Design as per IS456: 2000, the probability of failure of a structure is _____.

A. 0.097 B. 0.6

C. 0.067 D. 0.7

Ans. A

Sol. As we consider fck as the value of compressive strength for a sample below which not more than 5% specimen are expected to fail.

∴ Chances of no failure = 100 – 5 = 95%

So, probability of failure = $\left[1 - P^2\right] = \left(1 - 0.95^2\right) = 0.0975$

62. For a beam of cross–section, width = 230 mm and effective depth = 500 mm, the number of rebars of 12 mm diameter required to satisfy minimum tension reinforcement requirement specified by IS : 456–2000 (assuming grade of steel reinforcement as Fe 500) is _____

A. 1 B. 4

C. 2 D. 3

Ans. C

Sol. Correct answer is 2.

Given beam of width b = 230 mm; depth d = 500 mm; Rebars of yield strength $f_y = 500 N/\text{mm}^2$ and diameter 12 mm are to be used.

According to IS: 456-2000, minimum tension reinforcement is A_{st}

So $\frac{A_{st}}{bd} = \frac{0.85}{f_y}$

Let n bars of 12 mm φ be used so

$$\frac{n \times \frac{\pi}{4} \times (12)^2}{230 \times 500} = \frac{0.85}{500} \Rightarrow n = 1.72$$

But number of bars = 2

63. If the loading on a simply supported prestressed concrete beam is uniformly distributed, the centroid for the pre-stressing tendon should be as

A. A straight profile along the lower edge of the kern

B. A parabolic profile with convexity downward

C. A straight profile along the centroidal axis

D. A circular profile with convexity upward

Ans. B

Sol. The centroid profile as tendon must be provided such that section is under uniform compression. For uniformly distributed loading a parabolic profile with convexity downward is provided.

64. Consider the following cases in the design of reinforced concrete members in flexure:

1) Over-reinforced section

2) Tension failure

3) Compression failure

4) Under-reinforced section

Which of the above cases are considered for the safe design of R.C members in flexure?

A. 1 and 2 only B. 2 and 4 only

C. 3 and 4 only D. 1 and 3 only

Ans. B

Sol. An under-reinforced section which results in tension failure gives ample warning before the collapse.

So, both 2 & 4 are correct!

65. Consider the following statements in the light of IS: 456 - 2000:

1) There is an upper limit on the nominal shear stress in beams (even with shear reinforcement) due to the possibility of crushing of concrete in diagonal compression.

2) A rectangular concrete slab whose length is equal to its width may not be a two-way slab for certain definable support conditions.

Which of the above statements is/are correct?

A. 1 only B. 2 only

C. Both 1 and 2 D. Neither 1 nor 2

Ans. C

Sol. (i) General l y concrete is strong in compression but under shear there is a chance of crushing of concrete due to diagonal compression hence an upper limit τ_{cmax} is defined for nominal shear stress in diagonal compression.

(ii) A rectangular concrete slab whose length is equal to its width may not be a two way slab when there is absence of supports in two parallel edges. In this case it would be one way slab.

66. The environmental exposure condition of concrete buried under aggressive sub soil or ground water is classified as

A. moderate B. severe

C. very severe D. extreme

Ans. C

Sol.

Recommended Durability Requirements in IS 456 (2000)

Environmental exposure conditions	Min cement content+ kg/m^3	Max free w/c	Min concrete grade#	Min cover depth (mm)*
Mild: Concrete surfaces protected against weather or aggressive conditions, except those situated in coastal area	300	0.55	M 20	20**
Moderate: Concrete surfaces sheltered from severe rain or freezing whilst wet; concrete exposed to condensation and rain; concrete continuously under water; concrete in contact or buried under non-aggressive soil/ ground water; concrete surfaces sheltered from saturated salt air in coastal area	300	0.50	M 25	30
Severe: Concrete surfaces exposed to severe rain, alternate wetting and drying or occasional freezing whilst wet or severe condensation; concrete completely immersed in sea water; concrete exposed to coastal environment	320	0.45	M 30	45***
Very severe: Concrete surfaces exposed to sea water spray, corrosive fumes or severe freezing conditions whilst wet; concrete in contact with or buried under aggressive sub-soil/ground water	340	0.45	M 35	50***
Extreme: Surface of members in tidal zone; members in direct contact with liquid/ solid aggressive chemicals	360	0.40	M 35	75

67. In shear design of an RC beam, other than the allowable shear strength of concrete (τ_c), there is also an additional check suggested in IS 456-2000 with respect to the maximum permissible shear stress ($\tau_{c\,max}$) . The check for τ_{cmax} max is required to take care of

A. additional shear resistance from reinforcing steel

B. additional shear stress that comes from accidental loading

C. possibility of failure of concrete by diagonal tension

D. possibility of crushing of concrete by diagonal compression

Ans. D

Sol. If $\tau_v > \tau_{c,max}$, diagonal compression failure occurs in concrete

68. 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 tie reinforcement would 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 @ 300 mm c/c

Ans. C

Sol. Given column size is 350 mm × 350 mm.

Reinforcement 4 – 25 mm diameter bar and 4 – 16 mm diameter bars.

As per clause 26.3.2 of IS 456:2000, diameter of tranverse bar is

Maximum of $\begin{cases} (i)\left(\frac{1}{4}\right) diameter\ of\ largest\ longitudinal\ bar = \frac{1}{4}\times 25 = 6.25 \simeq provide 8\,mm \\ (ii)\ 6\,mm \end{cases}$

Spacing, S_v = min of $\begin{cases} \text{(i) Least lateral dimension of column} = 350\,\text{mm} \\ \text{(ii) } 16\times \text{smallest diameter bar of longitudinal reinforcement} = 256\ \text{mm} \\ \text{(iii) } 300\,\text{mm} \end{cases}$

= 256 mm or taking it as 250 mm.

So, provide 8 mm φ @250 mm, as transverse reinforcement.

69. From limiting deflection point of view, use of high strength steel in RC beam results in _____.

A. Reduction in depth

B. No change in depth

C. Increase in depth

D. Increase in width

Ans. C

Sol. Deflection criteria for simply supported beam should be <20, for continuous beam <26 & for cantilever beam <7. These factors also have to be multiplied with modification factor K1, K2, K3 & K4.

As the value of tension reinforcement increases modification factor decreases thus leading to increase in depth.

70. The loss of pre-stress due to shrinkage of concrete is the product of _____.

A. Modular ratio and percentage of steel

B. Modulus of elasticity of concrete and shrinkage of concrete

C. Modulus of elasticity of steel and shrinkage of concrete

D. Modular ratio and modulus of elasticity of steel

Ans. C

Sol. The loss of pre-stress due to shrinkage of concrete is the product of Modulus of elasticity of steel and shrinkage of concrete.

71. Reinforced concrete slabs are designed for

1) Shear

2) Flexure

3) Positive bending moment

4) Negative bending moment

A. 1, 2 and 3 only

B. 1 and 4 only

C. 2, 3 and 4 only

D. 1, 2, 3 and 4

Ans. C

Sol. Slabs are designed for bending and def lection and not designed for shear because

(i) Slabs have much small depth than beams.

(ii) Most of slabs subjected to uniformly distributed loads.

72. When a spirally reinforced short column is loaded axially, the concrete inside the core is subjected to

A. Bending and compression

B. Biaxial compression

C. Triaxial compression

D. Uniaxial compression

Ans. C

Sol. The concrete inside the core is subjected to tri-axial compression. It is confined by hoop stress in spiral reinforcement and axial load transfer path.

73. As per Indian Standard code of practice for prestressed concrete (IS 1343 - 1980), the minimum grade of concrete to be used for post tensioned and pretensioned structural elements are respectively

A. M_{20} for both

B. M_{40} & M_{30}

C. M_{15} & M_{20}

D. M_{30} & M_{40}

Ans. D

Sol. Higher the grade of concrete higher the bond strength which is vital in pretensioned concrete, Also higher bearing strength which is vital in post-tensioned concrete. Further creep & shrinkage losses are minimum with high-grade concrete. Generally minimum M30 grade concrete is used for post-tensioned & M40 grade concrete is used for pretensioned members.

74. The reduction coefficient of a reinforced concrete column with an effective length of 4.8 m and size $250 \times 300 \text{mm}^2$ is _____.

A. 0.8 B. 0.85

C. 0.9 D. 0.95

Ans. B

Sol. Reduction coefficient C_r =(1.25 – L_{eff}/48B)

L_{eff} =4.8 m and B = 250 mm

So C_r = 0.85

75. For design of Flexure members, the strain in the reinforcing bars under tension at ultimate state as per IS 456-2000 shall not be less than

A. f_y/1.15E B. f_y/1.15E_s+0.002

C. f_y/E_s D. f_y/E_s+0.002

Ans. B

Sol. As per IS 456-2002, the strain should not be less than f_v/1.15E_s+0.002.

76. What is the limiting principal tensile stress in pre-stressed uncracked concrete member of M25 grade?

A. 1.2 MPa B. 1.5 MPa

C. 2 MPa D. 2.5 MPa

Ans. A

Sol. The limiting principal tensile stress in an uncracked member is given by

$f_t = 0.24\sqrt{f_{ck}}$

$= 0.24 \times \sqrt{25}$

= 1.2 MPa

77. Match **List-I** (Prestressing system) with **List-II** (Type of anchorage) and select the correct answer using the codes given below the lists:

List-I

A) Hoyer

B) Gifford Udall

C) Lee-Mc call

D) Magnel Blaton

List-II

1) Flat steel wedges in sandwitch plated

2) High strength nuts

3) Split conical wedges

4) Stretching the wires between two bulk heads at a large distance apart

A. A-2, B-1, C-4, D-3 B. A-4, B-3, C-2, D-1

C. A-4, B-1, C-2, D-3 D. A-2, B-3, C-4, D-1

Ans. B

Sol. A) Hoyer- Stretching the wires between two bulk heads at a large distance apart

B) Gifford Udall- Split conical wedges

C) Lee-Mc call- High strength nuts

D) Magnel Blaton- Flat steel wedges in sandwitch plated

78. The purpose of lateral ties in a short RC column is to

A. Avoid buckling of longitudinal bars

B. Facilitate compaction of concrete

C. Increase the load carrying capacity of the column

D. Facilitate construction

Ans. A

Sol. The main functions of lateral reinforcements in RC columns are:

- It prevents longitudinal reinforcement bars from **buckling**,
- It resists the shear force and hence contributes **avoiding shear failure**,
- It *confines* the concrete core to provide sufficient **ductility** or deformability, and
- It restrains the spliced bars and hence prevents their **sliping**.

79. If a beam is likely to fail due to high bonding stresses, then its bond strength can be increased most economically by

A. Providing vertical stirrups

B. Increasing the depth of the beam

C. Using smaller diameter bars in correspondingly more numbers

D. Using higher diameter bars by reducing their numbers

Ans. C

Sol. To increase bond strength, we should use smaller diameter bars in correspondingly large numbers (such that area of steel remains same). This would effectively increase surface area of contact between steel and concrete.

Stirrups are used in beams to counter shear force. Increase in depth of beam would not bring any change in bond strength.

80. As the span of a bridge increases, how does the impact factor vary?

A. It decreases

B. It increases

C. It remains constant

D. It increases up to a critical value of span and then decreases

Ans. A

Sol. Impact factor for RC bridges,

$I = 4.5 / 6+L$

Where L is the length of span in meters.

81. A prestressed concrete beam with a cross section of 300 mm width and 600 mm depth, is 12 m long. IT carries a load of 12 kN/m inclusive of its self weight. It is prestressed with 2000 mm^2 high tensile steel located at 175 mm from soffit. The cable profile is straight for

full length of the beam and it is stressed to a level of 800 N/mm^2. It is bonded to concrete. The eccentricity (in mm) of thrust line at mid span in the beam is

A. 10 B. 12

C. 20 D. 60

Ans. A

Sol. Bending moment at mid span,

$$M = \frac{wl^2}{8}\frac{12\times((12)^2}{8} = 216\,kNm$$

Prestressing force,

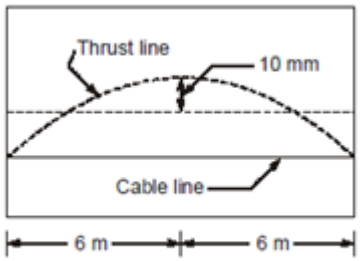
$$P = A_{st}\times f_s = 2000\times 800 = 1600\,kN$$

Shift of thrust line,

$$a = \frac{M}{P} = \frac{216\times10^6}{1600\times10^3} = 135\,mm$$

Eccentricity = 300 – 175 = 125 mm

Eccentricity of thrust = 135 – 125 = 10 mm



82. Deep beams are designed for _____.

A. Shear force only

B. Bending moment only

C. Both shear force and bending moment

D. Bearing

Ans. B

Sol.

1. A beam, whether deep or conventional, is always designed for bending moment, apart from **checks for safety in shear, deflections and cracking**.
2. A beam is said to be deep when the ratio of its effective span to overall depth is greater than 2 for simply supported beams, or 2.5 for continuous beams.
3. A deep beam complying with the requirements of 29.2 and 29.3 of IS 456:2000 shall be deemed to satisfy the provisions for shear.
4. Often the side faces in deep beams may be subjected to torsion under accidental loads or eccentricities.
5. Hence, when the depth of a beam exceeds 750mm, IS 456:2000 recommends providing *side face reinforcement* along the two faces: total area of this reinforcement

should not be less than 0.1% of the web area, and should be distributed on the two faces equally with a spacing not exceeding 300mm or web thickness, whichever is lesser.

83. If the size of panel in a flat slab is $6\text{m} \times 6\text{m}$, then as per Indian Standard code the width of column strip and middle strip are _____.

A. 3.0 m and 1.5 m
B. 1.5 m and 3.0 m
C. 3.0 m and 3.0 m
D. 1.5 m and 1.5 m

Ans. B

Sol. Components of flat slab design:

a) Column strip :

Column strip means a design strip having a width of 0.25L, but not greater than 0.25 L, on each side of the column centre-line, where L, is the span in the direction moments are being determined, measured centre to centre of supports and L, is the -span transverse to L, measured centre to centre of supports.

b) Middle strip :

Middle strip means a design strip bounded on each of its opposite sides by the column strip.()

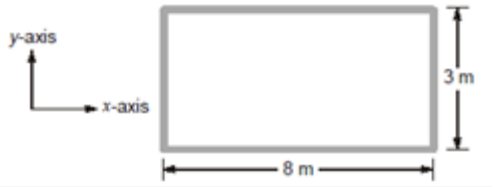
c) Panel:

Panel means that part of a slab bounde d on-each of its four sides by the centre -line of a Column or centre-lines of adjacent-spans.

So, Column Strip = 6/4 = 1.5m

Middle Strip = 6-1.5-1.5 = 3m

84. If the slab shown below is simply supported on all four sides, then the type of reinforcement provided in x-direction is



A. tensile reinforcement and distribution bars
B. compressive and temperature reinforcement
C. tensile reinforcement only
D. distribution bars

Ans. D

Sol. Given slab is oneway as 8/3 > 2

So in Y-direction (3) main reinforcement should be provided while in X-direction (8) distribution bar should be provided.

85. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I

A) IS 1343

B) IS 1893

C) IS 3370

D) IS 8041

List-II

1) Prestressed concrete

2) Liquid storage structure

3) Earthquake resistant design

4) Rapid hardening Portland cement

A. A-1, B-2, C-3, D-4 B. A-4, B-3, C-2, D-1

C. A-1, B-3, C-2, D-4 D. A-4, B-2, C-3, D-1

Ans. C

Sol. A) IS 1343- Prestressed concrete

B) IS 1893- Earthquake resistant design

C) IS 3370- Liquid storage structure

D) IS 8041- Rapid hardening Portland cement

86. Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I

A) IS 1343

B) IS 1893

C) IS 3370

D) IS 8041

List-II

1) Prestressed concrete

2) Liquid storage structure

3) Earthquake resistant design

4) Rapid hardening Portland cement

A. A-1, B-2, C-3, D-4 B. A-4, B-3, C-2, D-1

C. A-1, B-3, C-2, D-4 D. A-4, B-2, C-3, D-1

Ans. C

Sol. A) IS 1343- Prestressed concrete

B) IS 1893- Earthquake resistant design

C) IS 3370- Liquid storage structure

D) IS 8041- Rapid hardening Portland cement

87. The long term elastic modulus (in N/mm^2) of concrete whose age of concrete at loading is equal to 28 days is (in integer value)

[Take M20 grade of concrete and creep coefficient is 1.6 at 28 days of concrete at loading]

A. 8600 B. 10000

C. 13975 D. 9600

Ans. A

Sol. For M20, f_{ck} =20 MPa

$$E_{c\theta} = \frac{E_c}{1+\theta} = \frac{5000\sqrt{f_{ck}}}{1+\theta}$$

$$= \frac{5000\sqrt{20}}{1+1.6} = 8600 Mpa$$

88. In a post-tension pre-stressed concrete beam, the end block zone is in between the end of the beam and the section where

A. The shear stresses are maximum B. Only shear stresses exist

C. No lateral stresses exist D. Only longitudinal stresses exist

Ans. D

Sol. The zone between the end of the beam and the section where only longitudinal stress exist is generally referred to as the anchorage zone or end block zone.

89. The reduction coefficient of a reinforced column with an effective length of 6 m and size 400 mm × 450 mm is

A. 0.83 B. 0.94

C. 0.97 D. 0.99

Ans. B

Sol. Reduction coefficient,

$$C_r = \left(1.25 - \frac{L_{eff}}{48B}\right) or \left(1.25 - \frac{L_{eff}}{48D}\right)$$ whichever is smaller

$$\Rightarrow C_r = \left(1.25 - \frac{6000}{48 \times 400}\right) or \left(1.25 - \frac{6000}{48 \times 450}\right)$$

$$\therefore C_r = 0.9375 \approx 0.94$$

90. As compared to the working stress method of design, the limit state method of design premises that the concrete can admit

A. A lower stress level

B. A higher stress level

C. Occasionally higher, but usually lower, stress level

D. Only the same stress level

Ans. B

Sol. LSM of design for RCC pushes the stress limit to the higher side

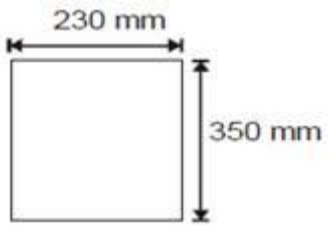
91. A rectangular 230 mm × 350 mm beam is (effective depth). The factored shear force acting at a section is 80 kN. If the permissible shear stress in concrete is 0 ·25 MPa, the design shear force is nearly

A. 100 kN B. 80 kN

C. 60kN D. 20 kN

Ans. C

Sol.



Shear force resisted by concrete section only

(F_c)

$= 230 \times 350 \times 0.25 \times 10^{-3}$

$= 20.125$ kN

Design shear force (that will be resisted by shear stirrups)

F_d= factored shear force – F_c

$F_d = 80 - 20.125$

$F_d = 59.875\ kN$

$\boxed{F_d = 60\ kN}$

92. A RC beam of rectangular cross section of breath 250 mm and effective depth 450 mm is subjected to a service shear force of 80 kN. For the area of main reinforcement provided, the design shear strength τ_c as per IS 456: 2000 is 0.48 MPa. The most effective spacing (in mm) of 2-legged 8 mm vertical stirrups to be provided is [Take M20 grade concrete and Fe250 grade steel]

A. 100 B. 140

C. 210 D. 300

Ans. B

Sol. Factored design shear force, V_u = 1.5 x 80 = 120 kN

Shear capacity of concrete, $V_{uc} = \tau_c$ bd

= 0.48 x 250 x 450 = 54 kN

For vertical stirrups, design shear force, $V_{us} = V_u - V_{uc}$ = 66 kN

Spacing, $S_v = \dfrac{0.87 f_y A_{sv} d}{V_{us}}$

$= \dfrac{0.87 \times 250 \times 2(\pi \times 8^2) \times 450}{66 \times 4 \times 1000}$

$\therefore\ S_v = 149.08\ mm$

93. A column is regarded as long column if the ratio of its effective length and lateral dimension exceeds _____.

A. 10 B. 15

C. 20 D. None of these

Ans. D

Sol. A column is regarded as long column if the ratio of its effective length and lateral dimension exceeds 12.

94. A short column 20 cm x 20 cm in section is reinforced with 1 bar whose area of cross section is 20 sq.cm. If permissible compressive stresses in concrete and steel are 40 kg/cm^2 and 300 kg/cm^2, the safe load on the column should not exceed _____.

A. 412 kg
B. 4120 kg
C. 412000 kg
D. None of these

Ans. D

Sol. Permissible load on short column = Stress in concrete x area of concrete + stress in steel x area of steel

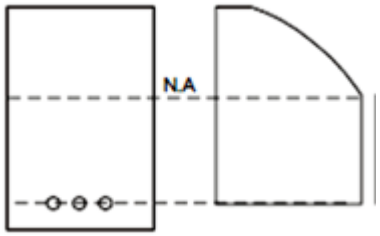
W = 40x(20x20 - 20) + 20x300 =21200kg.

95. In a reinforced concrete section, shear stress distribution is diagrammatically

A. Wholly Parabolic
B. Wholly Rectangular
C. Parabolic above NA and Rectangular below NA
D. Rectangular above NA and Parabolic below NA

Ans. C

Sol.



96. In the design of pre-stressed concrete structures, which of the following limit states will qualify as the limit states of serviceability?

1) Flexural
2) Shear
3) Deflection
4) Cracking

A. 1 and 2 only
B. 3 and 4 only
C. 1 and 4 only
D. 2 and 3 only

Ans. B

Sol. In the method of design based on limit state concept, the structure shall be designed to safely all loads liable to act on it. The resistance to bending, shear, torsion and axial loads at every section shall not be less than the appropriate value at that section produced by the probable most unfavorable combination of loads on the structure using the appropriate partial safety factors. This constitutes assessing limit state of collapse. The structure shall also satisfy limit states of serviceability requirements, such as limitations on deflection and cracking.

97. A reinforced concrete (RC) beam with width of 250 mm and effective depth of 400 mm is reinforced with Fe415 steel. As per the provisions of IS 456-2000, the minimum and maximum amount of tensile reinforcement (expressed in mm^2) for the section are, respectively

A. 250 and 3500 B. 205 and 4000

C. 270 and 2000 D. 300 and 2500

Ans. B

Sol. Given: Width of beam (b) = 250mm

Effective depth (d) =400 mm

As per IS-456:200

From clause 26.5.1.1 (a)

Minimum tension reinforcement

$$\frac{A_{st}}{bd} = \frac{0.85}{f_y}$$

$$A_{st} = \frac{0.85 \times 250 \times 400}{415} = 205\ mm^2$$

From clause 26.5.1.2(b)

Maximum tension reinforcement $= 0.04bd = 0.04 \times 250 \times 400 = 4000\ mm^2$

98. Consider a rectangular RC beam for the following data, Effective width = 300 mm, Effective depth = 800 mm, Overall depth = 850 mm, Factored bending moment = 200 kNm, Factored shear moment = 100 kN, Factored torsional force = 95 kNm, Characteristic strength of concrete = 20 MPa and Yield strength of steel = 415 MPa. What will be the equivalent shear (in kN) and equivalent bending moment (in kN-m)?

A. 606.67 and 450.84 B. 547.33 and 485.67

C. 606.67 and 414.22 D. 547.33 and 414.22

Ans. C

Sol. Equivalent shear,

$$V_e = V_u + 1.6\frac{T_u}{b}$$

$$= 100 + 1.6 \times \frac{95}{0.3} = 606.67\ kN$$

Equivalent bending moment,

$$M_e = M_u + M_t$$

$$= M_u + \frac{T_u}{1.7}\left(1 + \frac{D}{B}\right)$$

$$= 200 + \frac{95}{1.7}\left(1 + \frac{850}{300}\right) = 200 + 214.22$$

M_e = 414.22 kNm

99. If a concrete column 200 x 200 mm in cross-section is reinforced with four steel bars of 1200 mm^2 total cross-sectional area. What is the safe load for the column if permissible stress in concrete is 5 N/mm^2 and $E_s = 15\ E_c$?

A. 264 kN B. 274 kN

C. 284 kN D. 294 kN

Ans. C

Sol. Permissible stress in steel/permissible stress in concrete = Es/Ec.

Permissible stress in steel = 5 * 15Ec/Ec = 75 N/mm^2

Now,

P = 5 x (200 x 200 - 1200) + (1200 x75) = 284000N = 284 kN

100. As per IS 456 – 2000, the maximum permissible shear stress, τ_{cmax} is based on

A. Diagonal tension failure B. Diagonal compression failure

C. Flexural tension failure D. Flexural compression failure

Ans. B

Sol. τ_{max} is based on diagonal compression failure. The shear stress is to be restricted in order to avoid the crushing of the concrete.

****