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1. Answer C

Solution:

IS 456 : 2000 the limit of suspended matter in water to be used for construction is 2000 mg/l.

Permissible limit for solids

Constituents	Permissible limit (max.)
1. organic	200 mg/l
2. inorganic	3000 mg/l
3. sulphate	400 mg/l
4. chloride	2000 mg/l (without steel) 500 mg/l (with steel)
5. suspended matter	2000 mg/l

2. Answer C

Solution:

$f_y = 250\ N/mm^2$

$Z_p = 11 \times 10^4\ mm^3$

$\gamma_{mo} = 1.10$

For a laterally supported plastic steel beam, the design bending strength is:

$M_d = (\beta_b \times Z_p \times f_y) / \gamma_{mo}$

For a plastic section: $\beta_b = 1.0$

Therefore,

$M_d = (1.0 \times 11 \times 10^4 \times 250) / 1.10$

$M_d = 25 \times 10^6\ N\cdot mm$

$M_d = 25\ kN\cdot m$

3. Answer A

Solution:

As per IS 456 C1 26.2.1.1, Design Bond stress

Grade of concrete	(τ_{bd}) Permissible (WSM)	(τ_{bd}) Permissible (LSM)
M-15	0.6	-
M-20	0.8	1.2
M-25	0.9	1.4
M-30	1.0	1.5
M-35	1.1	1.7
M-40	1.2	1.9 ⇒ for M-40 and above
M-45	1.3	
M-50	1.4	

4. Answer B

Solution:

As per Table 10 of IS 800:2007, for a rolled I-section with:

$h/b_f > 1.2$ and $t_f \le 40$ mm,

the buckling class about the z–z axis is **Class-a**.

5. Answer A

Solution:

Workability can be defined as ease with which concrete can be compacted and ease of compaction depends upon quality of paste (i.e. lean paste or thick paste) and quality of paste in turn depends upon w/c ratio instead of water alone.

6. Answer A

Solution:

According to the IS code 456 : 2000 clause 23.3. A simply supported or continuous beam shall be so proportioned that clear distance between the lateral restraints does not exceed 60 b or 250 b^2/d whichever is less

Where, d= effective depth of the beam

b= breath of the compression face midway between the lateral restraints.

$$\left.\begin{array}{l} L \not> 60b \\ \not> 250\dfrac{b^2}{d} \end{array}\right\} \text{ whichever is less}$$

For cantilever beam; Clear distance between the free end of cantilever and lateral restrain shall not exceed.

25 b or $\dfrac{100b^2}{d}$ whichever is less.

7. Answer D

Solution:

Given plate size 100 mm × 10 mm

yield strength (f_y) = 250 MPa.

Area of cross-section of plate = 100 × 10 mm^2 = 1000 mm^2

partial safety factor of yield = 1.1

Design strength of plate =

$$\frac{\text{Area} \times \text{yield strength}}{\text{Partial safety factor}} = \frac{A_g \times f_y}{\gamma_{mo}}$$

$$= \frac{1000mm^2 \times 250N/mm^2}{1.1} = 227.27KN$$

8. Answer B

Solution:

⇒ Lap length - During placing the steel in RC structure if the required length of bar is not sufficiently available to make a design length then lapping is done.

⇒ Lap length is the minimum length that must be provided if two bars are joined together such that forces can be transferred safely.

Lap length in tension

(i) In flexure

$$\text{Lap length} \Rightarrow \text{Maximumm of} \begin{cases} L_d \\ 30\phi \end{cases}$$

(ii) In tension

$$\text{Lap length} \Rightarrow \text{max}^m \text{ of} \begin{cases} 2L_d \\ 30\phi \end{cases}$$

(iii) In Compression

$$\text{lap length} \Rightarrow \text{Max}^m \text{ of} \begin{cases} L_d \\ 24\phi \end{cases}$$

9. Answer A

Solution:

Economical depth of plate girder corresponds to minimum weight.

10. Answer B

Solution:

For mild and moderate exposure, if 20mm coarse aggregate are used, min cement per cubic meter of concrete must not be less than 300 kg/m² (for reinforced concrete).

Sl. No.	Expos-ure	Plain concrete			Reinforced concrete		
		Min. cement content kg/m³	Max. free water cement ratio	Min. Grade of concrete	Min. cement content kg/m³	Max. free water cement ratio	Min. Grade of concr-ete
1	2	3	4	5	6	7	8
(i)	Mild	220	0.60	-	300	0.55	M20
(ii)	Moderate	240	0.60	M15	300	0.50	M25
(iii)	Severe	250	0.50	M20	320	0.45	M30
(iv)	Very severe	260	0.45	M20	340	0.45	M35
(v)	Extreme	280	0.40	M25	360	0.40	M40

11. Answer D

Solution:

As per codal provisions, at simple supports and at points of inflection, +ve moment tension reinforcement shall be limited to a diameter such that L_d, does not exceed.

$$L_d \le \left(\frac{M_1}{V} + L_0\right)$$

The value of M_1/V may be increased by 30% when the ends of the reinforcement are confined by a compressive reaction

$$\text{i.e. } L_d \le \frac{1.3M_1}{V} + L_0 \ldots\ldots(i)$$

$$\text{Development Length } (L_d) = \frac{\phi\sigma_s}{4\tau_{bd}}$$

$\therefore$ eq. (i) can be written as

$$\frac{\phi\sigma_s}{4\tau_{bd}} \le \frac{1.3M_1}{V} + L_0$$

$$\text{Or, } \phi \le \left(\frac{1.3M_1}{V} + L_0\right)\frac{4\tau_{bd}}{\sigma_s}$$

12. Answer D

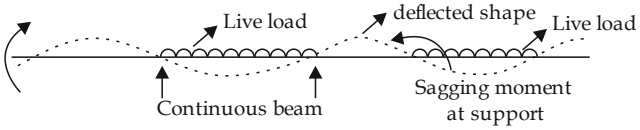
Solution:

1. In case of welded tension members, entire cross-sectional area of connected leg is condiered in effective area calculation, whereas for bolted connection, deduction for holes is made for connected leg.
2. As per IS 800 : 2007, two angles placed back-to-back and tack welded area assumed to behave as tee section.
3. As per IS 800 : 2007, check for slenderness ratio of tension members may be necessary to provide adequate rigidity to prevent accidental eccentricity of load or excessive vibration.

Thus, statement 1, 2 and 3 all are correct.

13. Answer C

Solution:



So, from the fig., for maximum sagging moment at support in a continuous RC beams live load should be placed on span next to the adjacent spans of the support plus alternate spans.

14. Answer A

Solution:

Acc. to IS: 800-2007 V>0.6 Vs

V = Applied shear force

V_S = Shear capacity of the steel

when a steel member is subjected to combined shear and bending no reduction in moment capacity of the section is necessary as long or the cross section is not subjected to high shear force. High shear force is define as V > 0.6 Vs.

15. Answer B

Solution :

$$\frac{2.6x + 6.8\times(1-x)}{1} = 5.4$$

$6.8x - 2.6x = 6.8 - 5.4$

$4.2x = 1.4$

$x = 1/3$

$x = 33.33\%$

16. Answer A

Solution:

$\frac{V_u}{bd} \rightarrow$ Nominal shear stress (τ_v)

$0.7\sqrt{f_{ck}} \rightarrow$ Modulus of rapture

$5000\sqrt{f_{ck}} \rightarrow$ Modulus of concrete (E_c)

$\frac{\phi f_s}{4\tau_{bd}} \rightarrow$ Development length (L_d)

17. Answer D

Solution:

If the sides of slab simply supported on edges (edges can be lifted) then factor multiplied with moment as follows

$$M_x = \left(\frac{r^4}{1+r^4}\right)\frac{wL_x^2}{8}$$

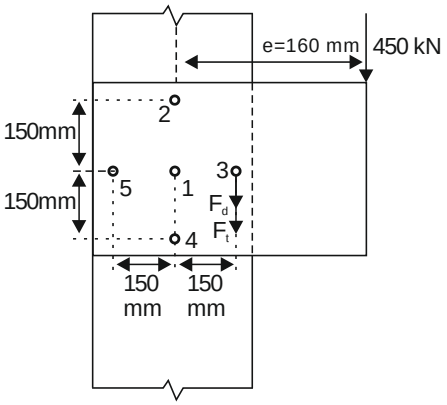
$$M_y = \left(\frac{r^4}{1+r^4}\right)\frac{wL_y^2}{8}$$

Where, $r = \frac{l_y}{l_x} = 1$ $\quad [l_y = l_x]$

Hence, multiplied Factor $= \frac{r^4}{1+r^4} = \frac{1^4}{1+1^4} = 0.5$

18. Answer D

Solution :



Rivet '3' is critical rivet, direct shear force on the rivet

$$(F_d) = \frac{450}{5} = 90\text{kN}$$

Torsional force on the rivet

$$(F_t) = \frac{Pe.R_i}{\Sigma r_i^2} = \frac{450\text{kN} \times 160 \times 150(\text{mm})^2}{4(150)^2\,\text{mm}^2}$$

= 120 kN

Resultant force on rivet

$$F_r = \sqrt{F_d^2 + F_t^2 + 2F_t F_d} = \sqrt{(120)^2 + (90)^2 + 2 \times 120 \times 90}$$

=210 kN

19. Answer B

Solution:

The eccentricities of major axis

$$(e) = \frac{\ell}{500} + \frac{D}{30} \text{ or } 20 \text{ mm}$$

$$e = \frac{3000}{500} + \frac{600}{30}$$

$$\boxed{e = 26\,\text{mm}}$$

The eccentricities of minor axis $(e) = \frac{3000}{500} + \frac{450}{30}$

$$\boxed{e = 21\,\text{mm}}$$

20. Answer D

Solution:

Total number of batch = $= \frac{7 \times 60}{3} = 140$

Output of concrete mixer = Discharge per batch × No. of batch

= 150 × 140 = 21000 liters

But the mixer discharges 90% of its capacity, hence practical output of concrete mixer = 0.9 × 21000 = 18900 litre

21. Answer A

Solution:

The longitudinal reinforcement shall be designed to resist an equivalent bending moment

$M_e = M_u + M_t$

Where, M_u= bending moment at the cross- section and

$$M_t = Tu\left(\frac{1 + D/b}{1.7}\right)$$

T_u is the torsional moment, D is the overall depth of the beam and b is the breadth of the beam.

22. Answer B

Solution :

In a gusseted base, the base plate projects beyond the outer edge of the gusset angle and behaves like a cantilever.

The maximum bending moment occurs at the fixed end of this cantilever, i.e., at the outer face of the gusset angle.

Therefore, the critical section for calculating the thickness of the base plate is **Section 2–2**

23. Answer A

Solution:

According to IS 456:2000 (Clause 36.1), the Limit State Method ensures that a structure does not reach the limit state during its design life.

- Statement 1: Correct – The structure should not collapse under the design loads.
- Statement 2: Correct – The structure should remain serviceable without excessive cracking or deflection.
- Statement 3: Incorrect – A structure should not reach a limit state during its design life.

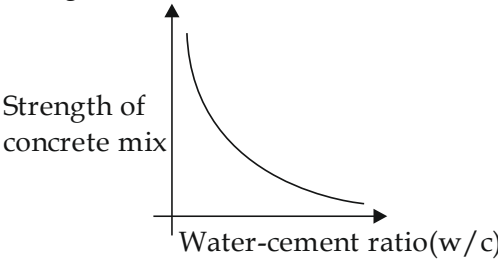
24. Answer C

Solution :

Water- cement Ratio & strength of cement is governed by abram's law, Detailed below-

Water-cement ratio	Effect on concrete
Low	High strength, dense concrete, low work
High	More workability, low strength

Thus, Assertion is true, However, Reason is false as an higher water cement ratio gives lower strength.



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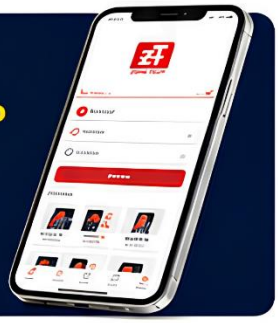

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25. Answer A

Solution:

Given - Dia of rod 20 mm. For a tension member subjected to reversed of stress due to action of wind, maximum slenderness ratio = 350

$\lambda=350$

$$\lambda = \frac{\text{effective length}}{\text{Least lateral dimension}}$$

Least lateral dimension $r_{min}= r_{mim} = \sqrt{\frac{I}{A}}$

$$r_{mim} = \sqrt{\frac{\frac{\pi d^4}{64}}{\frac{\pi d^2}{4}}}$$

$$r_{mim} = \sqrt{\frac{\frac{\pi (20)^4}{64}}{\frac{\pi (20)^2}{4}}} = 5$$

$$\therefore \lambda = \frac{I_{eff}}{r_{min}}$$

$$350 = \frac{I_{eff}}{5}$$

$l_{eff}=350\times5=1750$ mm

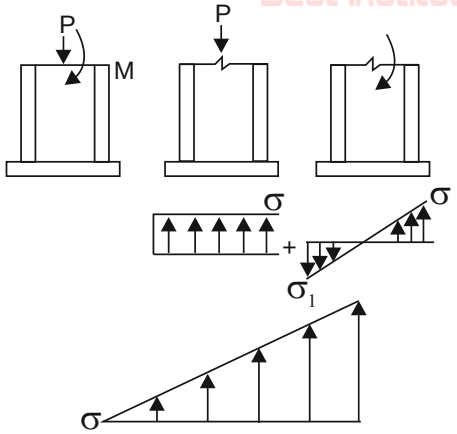
26. Answer D

Solution:

Generally the steps in a flight should not be more than 12.

27. Answer B

Solution:



28. Answer A

Solution :

Porosity and water absorpiton capacity of coarse aggregate affects the durability of concrete because of:

(i) Freezing and thawing

(ii) Reaction with chemically active fluid

(iii) Increasing the workability of concrete

29. Answer D

Solution:

- Minimum cover provided in the member is to check the durability, i.e., to prevent the corrosion of steel.
- Span / depth ratio limit governs the deflection of the R.C. member.
- Ultimate moment capacity of R.C. members is found by LSM.
- If load condition is such that depth of singly reinforced beam becomes very large, instead of designing singly reinforced beam we go for doubly reinforced beam.

30. Answer D

Solution:

As per the empirical design requirements for steel purlins:

Overall depth of purlin, D > 100t

Also,

$D \geq L/45$

where:

D = Overall depth of purlin

t = Thickness of purlin

L = Length or span of purlin

Therefore, the overall depth should be **greater than 100t and not less than L/45**.

31. Answer C

Solution:

- From the serviceability (deflection) point of view, using high-strength steel (Fe 415/Fe 500) increases the stress in reinforcement under service loads. This results in larger deflections.
- To satisfy the deflection limits prescribed by IS 456:2000, the beam must have a larger effective depth.
- Hence, from the limiting deflection point of view, the use of high-strength steel in an RC beam results in an increase in depth.

32. Answer C

Solution:

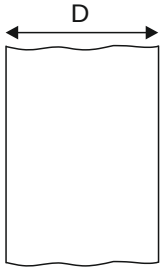
Geopolymer Concrete

The term 'Geopolymer' was coined by Davidovits in 1978. Geopolymer is an inorganic alumino-silicate polymer, synthesized from predominantly silicon and aluminium material such as fly ash. Alkaline solutions are used, to induce the silicon and aluminium atoms; in the source materials (fly ash), to dissolve to form gel. The polymerisation process may be assisted by applied heat followed by drying. The Geopolymer gel binds the loose coarse and fine aggregates to form geopolymer concrete.

Geopolymer gel replace the C-S-H gel in cement concrete. Chemical reaction period is substantially fast and the required curing period may be within 24 to 48 hours.
Geopolymer concrete usually requires heat curing (about 40°C-90°C) to speed up the chemical reaction (polymerization).

33. Answer A
Solution:
Wind pressure = $0.6 (V_Z)^2$
$= 0.6 \times (50)^2 = 1500 \text{ N/m}^2 = 1.5 \text{ kN/m}^2$

34. Answer A
Solution:
As per IS3370 (Part-2): 2009 Clause 8.1, the surface zone for walls is as follows:



For D < 500mm surface zone is D/2
For D > 500mm surface zone is 250 mm on either face

35. Answer C
Solution:

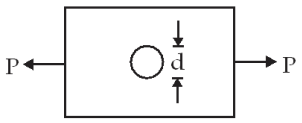


Figure 1

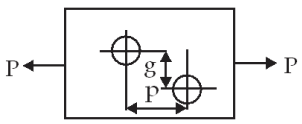


Figure 2

Tensile strength of plate in arrangement (2) will be greater than in arrangement (1),
As per IS code 800:2007 clause 6.3,

$$\left(0.9A_{net}\frac{f_{up}}{\gamma_{m1}}\right)_2 > \left(0.9A_{net}\frac{f_{up}}{\gamma_{m1}}\right)_1$$

$(A_{net})_2 > (A_{net})_1$

$$\left[\left(B - 2d + \frac{p^2}{4g}\right)t\right]_2 > [(B - d)t]_1$$

$$B - 2d + \frac{p^2}{4g} > B - d$$

$$\frac{p^2}{4g} > d$$

$$p^2 > 4gd$$

36. Answer B
Solution:
For 1 : 2 : 4 concrete, quantity of sand per unit volume of cement = $2m^3$.
Allowing 20% extra for bulking.
Volume of sand required = $1.2 \times 2 = 2.4 \text{ m}^3$

37. Answer A
Solution:
Assumption: Limit state of collapse in flexure (clause 38.1)
(i) Plane sections normal to the axis remains plane after bending.
(ii) The maximum strain in concrete at the outermost compression fibre is taken as 0.0035.
(iii) The relationship between the compressive stress distribution in concrete and the strain in concrete may be assumed to be rectangle, trapezoid parabola or any other shape which results in prediction of strength in substantial agreement with the test results.
(iv) The tensile strength of concrete is ignored.
(v) The maximum strain in the tension reinforcement in the section at failure shall not be less than : $\frac{f_y}{1.15E_{st}} + 0.002$

where, f_y = characteristic strength of steel, and
E_{st}= modulus of elasticity of steel

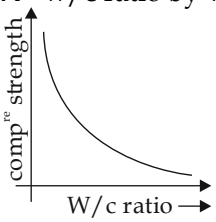
38. Answer A
Solution:
The web crippling strength is calculated as

$$(b_1 + n_2)t_w \frac{f_y}{\gamma_{wo}}$$

39. Answer B
Solution:
Statment I is correct because the water cement ratio is a crucial factor that influences both the strength and durability of concrete as strength of concrete primarily depends upon the strength of cement paste and strength of cement paste depends on dilution of paste (or) strength of paste increases with cement content and decreases with air and water content.
As per Duff Abrahm's Law: It is evident that strength of concrete depends only upon w/c ratio provided the mix is workable.

Stregnth at 28 days (S) = $\frac{A}{Bx}$

Where
$A = 98.4 \text{ N/mm}^2$
B = 7
X= w/c ratio by volume



40. Answer C

Solution:

For the analysis of a two-way slab, both Marcus' Method and Pigeaud's Method are used.

- Marcus' Method : Used for two-way slabs carrying uniformly distributed loads.
- Pigeaud's Method : Used for two-way slabs subjected to concentrated loads.

Therefore, both methods are applicable.

41. Answer D

Solution:

Flexure - Longitudinal steel

Shear - Stirrups

Bond - Anchorage in supports

Deflection - Minimum depth of section.

42. Answer B

Solution :

Size of fillet weld,

s = 6 mm

Working stress of fillet weld,

$\tau = 100\ MPa = 100\ N/mm^2$

The tie bar is welded on three sides.

Total length of weld,

L = 100 + 100 + 100

L = 300 mm

Effective throat thickness of fillet weld,

t = 0.7s

t = 0.7 × 6

t = 4.2 mm

Strength of weld,

P = t × L × τ

P = 4.2 × 300 × 100

P = 126000 N

P = 126 kN

43. Answer C

Solution:

According to IS 456, the area of longitudinal reinforcement in a reinforced concrete column shall not exceed 6% of the gross cross-sectional area of the column.

Other options are incorrect because:

- Circular columns may be provided with either helical reinforcement or circular lateral ties.
- The maximum spacing of lateral ties is limited to 16 times the diameter of the smallest longitudinal bar, not the tie bar.
- Longitudinal bars must be properly restrained by lateral ties.

44. Answer C

Solution:

According to IS 800-1984

- As far as practicable, the lacing system shall not be varied throughout the length of the strut
- Single laced systems on opposite sides of the components shall preferably be in the same direction so that one be the shadow of the other.
- Rolled sections or tubes of equivalent strength may be used as lacing bars instead of flats.

45. Answer C

Solution:

The density of no-fines concrete made with conventional aggregates is in the range of 1600-1900 kg/m^3

46. Answer C

Solution:

For a slender compression member, the additional moments due to slenderness are:

and $M_{ax} = \frac{P_u l_{ex}^2}{2000\,D}$

$M_{ay} = \frac{P_u l_{ey}^2}{2000\,b}$

Where:

P_u= factored axial load

L_{er}, l_{ey}= effective lengths in x and y directions

D= overall depth of the column

b= width of the column

Therefore, the correct option is:

$\frac{P_u l_{ex}^2}{2000\,D}$ and $\frac{P_u l_{ey}^2}{2000\,b}$

47. Answer B

Solution:

The gross area of a rivet is taken as the cross-sectional area of the rivet hole

The distance between the centres of the rivets should not be less, than 2.5 times the nominal diameter of the rivet.

For attaching the lug angle to the gusset atleast two bolts or rivets shall be used.

48. Answer A

Solution:

Assertion (A) is true: Total losses in pre-tensioned concrete beams are higher compared to post-tensioned concrete beams.

Reason (R) is true: In pre-tensioning, elastic shortening loss always takes place because the prestress is transferred to the concrete immediately, compressing it.

In post-tensioning, if all bars/tendons are tensioned simultaneously, the loss due to elastic shortening is zero. Even if tensioned sequentially, the loss is much lower.

Correct Explanation: Because elastic shortening is a major inherent loss that heavily impacts pre-tensioned members but is highly minimized or avoided in post-tensioned members, Reason (R) is the direct technical cause behind Assertion (A).

49. Answer A

Solution:

It is one of the basic assumption in bearing type joints that each connection is assumed to transmit its proportional share of the applied load if the applied load passes through the centroid of the connector group.

50. Answer C

Solution:

Geopolymer concrete can be manufactured by using the low-calcium (ASTM Class F) fly ash obtained from coal-burning power stations. Most of the fly ash available globally is low-calcium fly ash formed as a by-product of burning anthracite or bituminous coal.

The primary difference between geopolymer concrete and Portland cement concrete is the binder. The silicon and aluminum oxides in the low-calcium fly ash reacts with the alkaline liquid to form the geopolymer paste that binds the loose coarse aggregates, find aggregates, and other un-reacted materials together to form the geopolymer concrete.

51. Answer B

Solution:

Two important assumptions are made for ideal beam behaviour.

(i) Compression flange of beam is restrained laterally.

(ii) Local buckling of elements is prevented.

52. Answer B

Solution:

In the design of prestressed concrete structures, the limit state of serviceability includes:

- Deflection
- Cracking

Flexure and shear are checked under the limit state of collapse (strength).

53. Answer D

Solution:

- In a plate girder of uniform cross-section where vertical stiffeners are required, they shall be provided through the length of the girder and be spaced regularly.
- This increases the capacity of the plate girder because of truss like behaviour
- Intermediate vertical stiffeners are provided to prevent the web from buckling due to combined action of shear force and bending moment.

54. Answer B

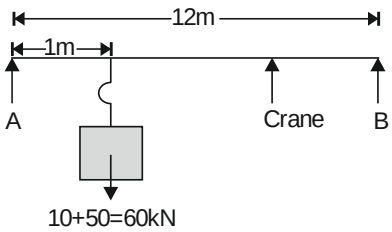
Solution:

Clause: 34.1.2 – Thickness at the Edge of Footing

"In reinforced and plain concrete footings, the thickness at the edge shall be not less than 150 mm for footings on soils, not less than 300 mm above the tops of piles for footings on piles."

55. Answer B

Solution:



(Trolley weight + Capacity)

Reaction of two wheels at A = R_A

$$= 60 \times \frac{11}{12} = 55\text{kN}$$

Reaction per wheel $= \frac{55}{2} = 27.5\text{kN}$

Reaction per wheel due to self weight of crane

$$= \frac{100}{4} = 25\text{kN}$$

Total Reaction on a wheel = 27.5+ 25= 52.5 kN

56. Answer C

Solution:

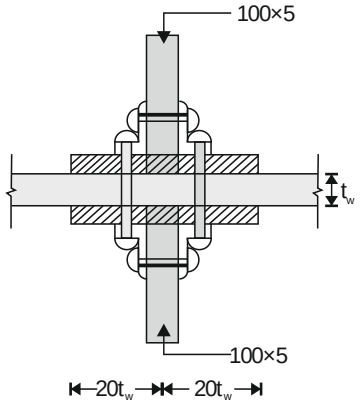
According to IS 456:2000:

- Statement 1:
  The area of longitudinal reinforcement shall be not less than 0.8% and not more than 6% of the gross cross-sectional area of the column.
- Statement 2:
  A helically reinforced circular column shall have a minimum of six longitudinal bars.

Therefore, both Statement 1 and Statement 2 are true.

57. Answer D

Solution:



Total effective area = $40 \times t_w \times t_w + 2 \times 100 \times 5$

$= 40 \times 10 \times 10 + 2 \times 100 \times 5$

$= 5000\ mm^2$

58. Answer C

Solution:

1. Local buckling → B
   Reason: Local buckling happens when individual plate elements (like the flange or web of a steel section) buckle locally before the entire column fails.
2. Squashing → D
   Reason: Squashing (or yielding) occurs in very short, stocky columns where the material reaches its full compressive strength without any buckling.
3. Overall flexural buckling → A
   Reason: This is the classic Euler buckling mode where the column experiences excessive lateral deflection along its weaker principal axis.
4. Flexural-Torsional buckling → C
   Reason: This failure mode involves a combination of bending (flexure) and twisting (torsion) about the shear center along the longitudinal axis.

59. Answer B

Solution:

Out of the given four shapes, the shape given in option (b) has equal moment of Inertia along both the principal axes and hence will have the maximum compressive load carrying capacity.

60 Answer B

Solution:

For concrete:

$f_{cr} = 0.7 \times \sqrt{F_{ck}}$

For M25 concrete:

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

$f_{cr} = 0.7 \times 5$

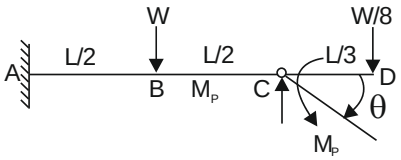
$f_{cr} = 3.5$ MPa

Correct Answer: 3.5 MPa

61. Answer A

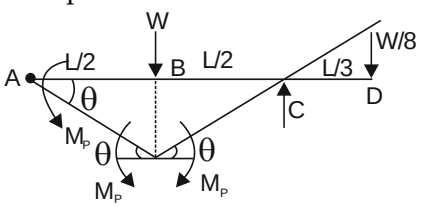
Solution:

Collapse mech-1



$$\frac{W}{8} \times \frac{L}{3}\theta = M_P\theta \Rightarrow W = \frac{24M_P}{L}$$

Collapse mech-2



$$W \times \frac{L}{2}\theta - \frac{W}{8} \times \frac{L}{3}\theta = 3M_P\theta$$

$$\frac{11}{24}WL\theta = 3M_P\theta$$

$$\Rightarrow W = 6.545\frac{M_P}{L}$$

62. Answer B

Solution :

Number of samples (n) = 37

Square of deviation $(x - \bar{x}) = 400\ MPa^2$

Standard deviation $(\sigma) = \sqrt{\frac{\sum(x-\bar{x})^2}{n-1}} = \sqrt{\frac{400}{37-1}}$

σ= 3.33 MPa

63. Answer B

Solution:

Cost of truss is inversely proportional to the spacing of truss,

$\therefore t = k_1 / s$

Cost of purlins is directly proportional to the square of spacing of trusses

$\therefore P = k_2 / s^2$

Cost of roof covering is directly proportional to the spacing of trusses

$\therefore r = k_3 s$

$\therefore$ Total cost = t + p + r

$C = k_1/s + k_2s^2 + k_3s$

For minimum cost, $\frac{dc}{ds} = 0$

$\therefore -k_1/s^2 + 2k_2s + k_3 = 0$

$\Rightarrow k_1/s + 2k_2s^2 + k_3s = 0$

$\Rightarrow -t+2p+ r = 0$

$\therefore t = 2p + r$

64. Answer D

Solution:

Reinforcement that will be required in central width band is :

$$\frac{\text{Reinforcement in central band width}}{\text{Total reinforcement in short direction}} = \frac{2}{\beta+1}$$

where,

β is the ratio of the longer side to the shorter side of the footing.

Longer side of footing = 3 m

The shorter side of footing = 2 m

Hence, $\beta = \frac{3}{2} = 1.5$

$$\frac{\text{Reinforcement in central band width}}{x} = \frac{2}{1.5+1} = 0.8$$

Reinforcement in central band width = 0.8x.

65. Answer A

Solution:

As per IS 800 : 2007

S.No.	Member	Maximum Slenderness Ratio
1	A tension member in which a reversal of direct stress due to loads other than wind or seismic forces occurs.	180
2	A member normally acting as a tie in a roof truss or a bracing system but subjected to possible reversal of stresses resulting from the action of the wind or earthquake forces.	350
3	Members always under tension (other than pre-tensioned members).	400

66. Answer C

Solution :

Grade of concrete = M20

Grade of steel = Fe415

$\phi = 12\text{mm}$

$L_d = ?$

$$L_d = \frac{0.87 f_y \phi}{4\tau_{bd}} \quad \{\tau_{bd} = 1.2\text{N/mm}^2$$

$$= \frac{0.87 \times 415 \times 12}{4 \times 1.6 \times 1.2} = 564.14 \simeq 564\,\text{mm}$$

67. Answer D

Solution:

As per **IS 456 : 2000 clause 31.7.1,** Spacing of bars in non-celluar, non-ribbed flat slab shall not exceed 2 times slab thickness

68. Answer C

b=200 mm V = 8 kN

d = 400 mm T=2 kN - m

Equivalent shear,

$$V_e = V + 1.6\left(\frac{T}{b}\right)$$

$$= 8\times10^3 + 1.6 \times \left(\frac{2\times10^6}{200}\right)$$

= 24000 N

Equivalent shear stress -

$$\tau_{eq} = \frac{V_e}{bd} = \frac{24000}{200\times400}$$

$= 0.3\ \text{N/mm}^2$

69. Answer B

Solution:

As per IS 456 : 2000 clause 10.2.2. the accuracy of measuring equipment shall be within 2% of quantity of cement being measured & within 3% of quantity of aggregate, admixture & water being measured.

70. Answer C

Solution:

Clause 35.3.2

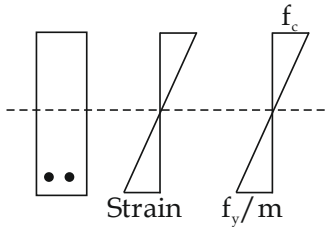
- The surface width of the cracks should not, in general, exceed 0.3 mm in members, where cracking is not harmful and does not have any serious adverse effects upon the durability of structure, i.e., not for particularly aggressive environment, such as the 'severe' category, the surface width of cracks should not, in general, exceed 0.1 mm.
- Cl 26.5.1.3 - side face reinforcement:
  where depth of the web in a beam exceeds 750 mm⇒ side face reinforcement is provided.
  The total area of such reinforcement shall not be less than 0.1% of the web area and distributed equally on two face.
- Cl 26.3.3 slabs-
  The horizontal distance between parallel main reinforcement bars shall not be more 3d or 300 mm whichever is smaller.

71. Answer A

Solution:

WSM is based on the assumption that concrete remains elastic upto failure for which stress $\propto$ strain.

In the WSM moment of resistance is calculated from the stress block which varies linearly like strain,



So with the increase of B.M. total compressive force and tensile force are assumed to increase in direction proportion and hence the lever arm remains unchanged.

72. Answer A

Solution:

To avoid buckling of compression flange, IS – 800 : 2007 specifies following web thickness requirements

(I) when transverse stiffeners are not provided $\frac{d}{t_w} \le 345\varepsilon_f^2$

(II) When only transverse stiffeners are provided

(i) $\frac{d}{t_w} \le 345\varepsilon_f^2$ for $c \ge 1.5d$

(ii) $\frac{d}{t_w} \le 345\varepsilon_f$ for $c < 1.5d$

where,

d = depth of the web

t_w = thickness of the web

$\varepsilon_f = \sqrt{\frac{250}{f_{yf}}}$

f_{yf}=yield stress of the compression flange

c = clean distance between transverse stiffener.

73. Answer A

Solution:

Plastic hinges are reached first at sections subjected to greatest curvature. After the formation of plastic hinge this section continue to rotate, offering at the same time a resistance equal to Mp, any further increase in load causes redistribution of moment until fully plastic moment is reached at each critical section. Mechanism is a situation in which sufficient number of plastic hinges are developed so as to cause the collapse of the structure without any further increase in load. Hence, the maximum load is attained when a mechanism forms.

74. Answer D

Solution

Assumptions in design of axially loaded column

- Max. compressive strain under axial compression = 0.002.
- Max. compressive strain in case of bending compression = 0.0035.
- Max. strain at highly compressed extreme fiber in a section subjected to axial compression and bending and when there is no tension in the section = 0.0035 - 0.75 × Strain in least compressed extreme fiber.
- Strain in tension reinforcement in a section at failure should not be less than $0.002 + \frac{0.87f_y}{E_s}$
- In the absence of data, total shrinkage strain = 0.0003.

75. Answer D

Solution:

Web crippling due to excessive bearing stress can be avoided by

- Increasing the web thickness as this will reduce bearing stress
- Providing bearing stiffeners will strengthen the web
- Increasing the length of the bearing plate will reduce the bearing stress.

76. Answer B

Solution:

As we know that

$x_u = \left(\frac{mc}{mc + t}\right)d$

Where,

d = 300 mm

x_u = 120 mm

C = 5 N/mm² (compressive stress)

m = 18

Hence,

$120 = \left(\frac{18 \times 5}{18 \times 5 + t}\right)300$

t = 135 N/mm²

77. Answer C

Solution:

In a gusseted base, when the end of the column is machined for complete bearing, it is assumed that 50% of the axial load is transferred by direct bearing and 50% through fastenings.

78. Answer C

Solution:

Reactive Powder Concrete is an ultra-high-strength concrete produced by using fine powders, low water-cement ratio, and often steel fibers to achieve very high strength and durability.

Characteristics of Reactive Powder Concrete:

Very high compressive strength (much higher than normal concrete).

No coarse aggregate (uses fine sand, cement, silica fume, quartz powder).

Low water-cement ratio.

Often contains steel fibers to improve ductility and toughness.

Very dense and durable.

Advantages of Reactive Powder Concrete:

Extremely high strength.

High durability and resistance to cracking.

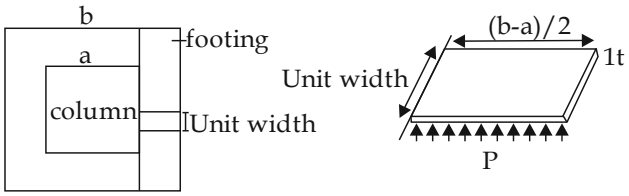
Good abrasion and impact resistance.

Uses

Bridges and long-span structures.

79. Answer C

Solution :



We know critical section for B.M is at a face of column hence considering a strip of unit width and calculating B.M at face of column

$$B.M = p\frac{(b-a)}{2}\frac{(b-a)}{4}\times 1$$

$$B.M = p\frac{(b-a)^2}{8} \text{ For unit width}$$

$$B.M = p\frac{b(b-a)^2}{8} \text{ for whole width of b}$$

80. Answer B

Solution:

Lug angles are used in the end connection inorder to decrease the length of the end connection.