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PTQ

Prelims Through Questions

for

ESE 2021

Civil Engineering

Day 5 of 11

Q.181 - Q.230

(Out of 500 Questions)

RCC + Design of Steel Structures

RCC + Design of Steel Structures

Q.181 For a continuous slab of effective depth 180 mm, what will be the effective span if clear distance between supports is 6 m and width of support is 300 mm?

(a) 4.38 m (b) 6.3 m
(c) 6.18 m (d) 4.5 m

181. (c)

$\because$ Clear distance between supports, $L_c = 6$ m

$$\therefore \quad \frac{L_c}{12} = \frac{6000 \text{ mm}}{12}$$

$$= 500 \text{ mm} > 300 \text{ mm (width of support)}$$

So, effective span will be given as

$$\text{Minimum of} \begin{cases} \text{Clear span} + d \\ \text{c/c distance between supports} \end{cases}$$

$$\text{Minimum of} \begin{cases} 6 + 0.18 \\ 6 + \dfrac{0.3}{2} + \dfrac{0.3}{2} \end{cases} = 6.18 \text{ m}$$

Q.182 Consider the following statements about 'Lap Splices':

1. Lap splices shall not be used for bars larger than 36 mm.
2. Lap length in compression shall be equal to the development length in compression, but not less than 24ϕ.
3. When bars of two different diameters are to be spliced, the lap length shall be calculated on the basis of diameter of smaller bar.
4. In case of bundled bars, lapped splices of bundled bars shall be made by splicing one bar at a time and staggered.

Which of the above statements are CORRECT?

(a) 2 and 4 (b) 1 and 2
(c) 2, 3 and 4 (d) All of these

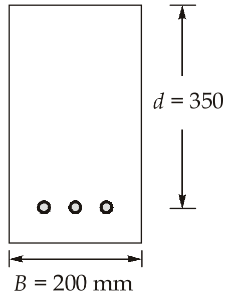
182. (d)

As per Clause 26.2.5.1 of **IS 456:2000.**

Q.183 A rectangular beam 200 mm wide has an effective depth of 350 mm. It is subjected to a bending moment of 24,000 Nm. The permissible stresses are c = 5 N/mm^2, t = 140 N/mm^2; and m is 18. The required area of tensile reinforcement will be

(a) 688 mm^2 (b) 778 mm^2
(c) 864 mm^2 (d) 954 mm^2

183. (b)



$$\text{Bending moment} = 24 \text{ kN-m}$$

$$c = 5 \text{ N/mm}^2$$

$$t = 140 \text{ N/mm}^2$$

$$K = \frac{mc}{t+mc} = \frac{18\times 5}{140+18\times 5} = 0.39$$

$$j = \left(1-\frac{K}{3}\right) = 0.87$$

$$Q = \frac{1}{2}c\cdot j\cdot K = \frac{1}{2}\times 5\times 0.87\times 0.39 = 0.85$$

$$MR_{bal} = QBd^2 = 0.85 \times 200 \times 350^2$$

$$= 20.83 \text{ kN-m}$$

Over reinforced section is required as BM > MR_{bal}

For over reinforced section,

$$x_a > x_c$$

$$c_a = \sigma_{cbc}$$

$$t_a < \sigma_{st}$$

Equating

$$\text{BM} = B\cdot x_a\cdot \frac{c_a}{2}\left(d-\frac{x_a}{3}\right)$$

$$24 \times 10^6 = 200\times x_a\times \frac{5}{2}\times\left(350-\frac{x_a}{3}\right)$$

$$48000 = 350x_a - \frac{x_a^2}{3}$$

$$\frac{x_a^2}{3} - 350x_a + 48000 = 0$$

$$x_a = 162.2 \text{ mm}$$

$$c_a = 5 \text{ N/mm}^2$$

$$\frac{c_a}{x_a} = \frac{t_a/m}{d-x_a}$$

$$t_a = \frac{c_a\times m\times(d-x_a)}{x_a}$$

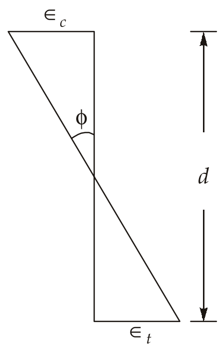
$$= \frac{5\times 18\times(350-162.2)}{162.2} = 104.2 \text{ N/mm}^2$$

$$A_{st} = \frac{BM}{t_a\left(d-\frac{x_a}{3}\right)} = \frac{24\times 10^6}{104.2\times\left(350-\frac{162.2}{3}\right)}$$

$$= 778 \text{ mm}^2$$

Q.184 A RCC beam has the following dimensions:
Length is 8 m, width is 300 mm, total depth is 650 mm, effective cover to tensile reinforcement is 50 mm.
The compressive strain in extreme concrete fibre is 0.0032.
Tensile strain in steel is 0.0042.
The curvature of the cross-section for given strains will be
(a) 1.138×10^{-5} mm^{-1}
(b) 2.467×10^{-5} mm^{-1}
(c) 1.233×10^{-5} mm^{-1}
(d) 9.25×10^{-5} mm^{-1}

184. (c)



Curvature, $\phi = \dfrac{\epsilon_c + \epsilon_t}{d}$

$\Rightarrow \quad \phi = \dfrac{0.0032 + 0.0042}{600} = 1.233 \times 10^{-5}\,\text{mm}^{-1}$

Q.185 What will be the area of minimum shear reinforcement in the form of stirrups (Fe415) provided at 250 mm c/c for a beam of width 400 mm?
(a) 110 mm^2
(b) 120 mm^2
(c) 95 mm^2
(d) 85 mm^2

185. (a)

$$\frac{A_{sv}}{b \cdot S_V} \geq \frac{0.4}{0.87 f_y}$$

$$\Rightarrow \quad A_{sv} \geq \frac{0.4 \times b \times S_V}{0.87 \times f_y}$$

$$\Rightarrow \quad A_{sv} \geq \frac{0.4 \times 400 \times 250}{0.87 \times 415} = 110.78 \text{ mm}^2 \simeq 110 \text{ mm}^2$$

∴ Minimum area of shear reinforcement = 45 mm^2

Q.186 The loss of prestress due to elastic shortening of concrete is least in
(a) one wire pre-tensioned beam
(b) one wire post tensioned beam
(c) multiple wire pre-tensioned beam with sequential cutting of wires
(d) multiple wire post-tensioned beam subjected to sequential prestressing

186. (b)

Q.187 Consider the following statements regarding the reinforcement detailing in shear walls :

1. The minimum amount of vertical and horizontal reinforcement as a ratio of gross concrete area should be 0.25%.
2. If the factored shear stress exceeds $0.25\sqrt{f_{ck}}$ or the wall thickness exceeds 200 mm, reinforcement should be provided in two curtains.
3. The diameter of the bars should not exceed $1/8^{th}$ of the thickness of that part.

Which of the above statements are CORRECT?

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

187. (a)

Diameter of bars should not exceed $1/10^{th}$ of the thickness of that part.

Q.188 A circular RCC water tank has an internal diameter of 10 m and has maximum height of water as 4 m. The thickness of wall is 160 mm and the walls of the tank are restrained at the base. IS-code coefficients for moment in cylindrical wall fixed to the base is given below.

$\frac{H^2}{DT}$	Coefficient at point		
	0.8H	0.9H	1.0H
10	+0.0028	–0.0012	–0.0122
12	+0.0026	–0.0005	–0.0104
14	+0.0022	–0.0001	–0.0090

Take unit weight of water as 9810 N/m^3

where, H = Height of tank, D = Diameter of tank, T = Thickness of wall

Then moment at the base of wall using the given table is

(a) 6520 Nm/m (b) 7687 Nm/m
(c) 5645 Nm/m (d) 7660 Nm/m

188. (d)

Given : H = 4 m, D = 10 m, T = 0.16 m

$$\frac{H^2}{DT} = \frac{4^2}{10 \times 0.16} = 10$$

The moment coefficient for the base (1.0 H) for $\frac{H^2}{DT} = 10$ is – 0.01222

$$\begin{aligned}\text{So, moment at base} &= -0.0122 \times \gamma_w H^3 \\ &= -0.0122 \times 9810 \times 4^3 \\ &= -7659.65 \text{ Nm/m} \\ &\simeq -7660 \text{ Nm/m}\end{aligned}$$

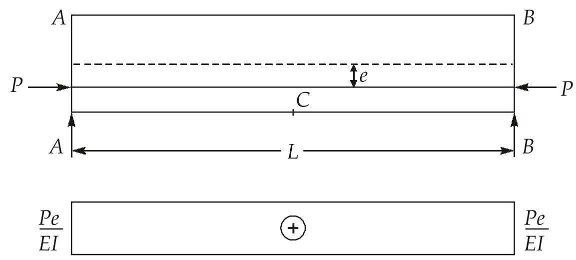
(–ve sign indicate tension at inner face)

Q.189 A simply supported post-tensioned prestressed concrete beam of span L is prestressed by a straight tendon at a uniform eccentricity 'e' below the centroidal axis. If the magnitude of prestressing force is P and flexural rigidity of beam is EI, the maximum central deflection of the beam is

(a) $\frac{PeL^2}{8EI}$ (downwards) (b) $\frac{PeL^2}{48EI}$ (upwards)

(c) $\frac{PeL^2}{8EI}$ (upwards) (d) $\frac{PeL^2}{4EI}$ (downwards)

189. (c)



$\frac{M}{EI}$ **Diagram**

Using moment area method

- Moment area between *A* and *C* about *A* gives deflection at *A* about tangent at *C*.
- As tangent at *C* is horizontal, so $\delta_A = \delta_C$

$\delta_A = \delta_C$ = Area moment of $\frac{M}{EI}$ diagram between *A* and *C* taken about *C*.

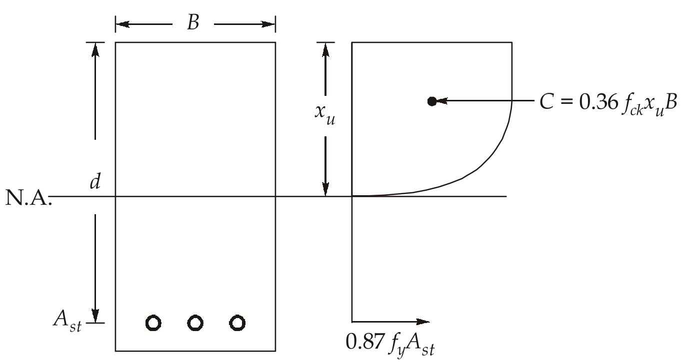
$$= \left(\frac{Pe}{EI} \times \frac{L}{2} \times \frac{L}{4}\right)$$

$$\Rightarrow \qquad \delta_C = \frac{PeL^2}{8EI}$$

Q.190 The factored compressive force developed in a RCC beam of width 300 mm and effective depth of 500 mm at limiting depth of neutral axis will be
[Use M30 and Fe415]

(a) 550 kN (b) 778 kN
(c) 620 kN (d) 982 kN

190. (b)



Compressive force in beam section is given as,

$$C = 0.36 f_{ck} B x_u$$

For maximum value of C,

$$x_u = x_{u\lim}$$

Where, $x_{u\lim} = 0.48 \times d = 0.48 \times 500 = 240$ mm

So, $C = 0.36 \times 30 \times 240 \times 300 \times 10^{-3}$ kN

$= 777.6$ kN $\simeq 778$ kN

Q.191 A doubly reinforced RCC beam of width 300 mm and total depth 550 mm is provided with 600 mm^2 of compression steel and 2000 mm^2 of tension steel. If effective cover to tension and compression reinforcement is 50 mm and stress in compression steel is given as 350 MPa then depth of neutral axis (approximately) from top will be

[Take M30 concrete and Fe415 steel]

(a) 80 mm (b) 120 mm
(c) 160 mm (d) 220 mm

191. (c)

Using, $C = T$

$\Rightarrow \quad 0.36 f_{ck}\, x_u\, b + (f_{sc} - 0.45 f_{ck}) A_{sc} = 0.87 f_y A_{st}$

$\Rightarrow \quad 0.36 \times 30 \times 300 \times x_u + (350 - 0.45 \times 30) \times 600 = 0.87 \times 415 \times 2000$

$\Rightarrow \quad x_u = 160.56 \text{ mm} \simeq 160 \text{ mm}$

Q.192 One third of the total reinforcement provided for negative moment at the support shall extend beyond the point of inflection for a minimum distance not less than,

1. the effective depth of the member.
2. 12ϕ
3. one-sixteenth of the clear span.

Which of the following statements is/are correct?

(a) Greater of 1 and 2 (b) Greater of 1 and 3
(c) Greater of 2 and 3 (d) Greater of 1, 2 and 3

192. (d)

Refer Clause 26.2.3.4 of IS 456 : 2000.

At least one-third of the total reinforcement provided for negative moment at the support shall extend beyond the point of inflection for a distance not less than the effective depth of the member or 12ϕ or one-sixteenth of the clear span whichever is greater.

Q.193 A continuous beam of *L*-section has following properties : Length of 6 m, flange thickness of 150 mm, web thickness of 250 mm and flange width of 1400 mm. The effective flange width will be

(a) 850 mm (b) 975 mm
(c) 612 mm (d) 550 mm

193. (d)

Given: $L = 6$ m

So, $l_0 = 0.7L$ for continuous beam

$= 0.7 \times 6 = 4.2$ m

$$\text{Effective flange width} = \text{Minimum of}\left[\left(\frac{0.5l_0}{\frac{l_0}{B}+4}+b_w\right), b\right]$$

$$= \frac{0.5\times 4200}{\frac{4200}{1400}+4} + 250 = 550 \text{ mm}$$

Q.194 As per **IS 456:2000** the minimum thickness at the edge for footing on soils and on piles respectively are

(a) 150 mm and 300 mm
(b) 200 mm and 300 mm
(c) 100 mm and 150 mm
(d) None of these

194. (a)

Q.195 A 20 storey RC framed building has plan dimensions 15 m × 30 m. Height of the building is 100 m. The fundamental period of vibration, if the building is unbraced, will be

(a) 1.2 sec
(b) 2.4 sec
(c) 4.5 sec
(d) 5.3 sec

195. (b)

For unbraced building, the fundamental period of vibration,

$$T = 0.075\ H^{0.75}$$
$$= 0.075\ (100)^{3/4}$$
$$= 0.075\times\frac{100}{(100)^{1/4}} = 0.075\times\frac{100}{10^{1/2}}$$
$$= 0.075 \times 31.623$$
$$= 2.37 \text{ sec} \simeq 2.4 \text{ sec}$$

Q.196 Match **List-I** (Beam variables) with **List-II** (Design provisions) and select the correct answer using the codes given below the lists:

List-I
A. Flexure
B. Shear
C. Bond
D. Deflection

List-II
1. Minimum depth of section
2. Longitudinal steel reinforcement
3. Stirrups
4. Anchorage in support

Codes :

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

196. (d)

Q.197 Minimum shear reinforcement in beams is provided in the form of stirrups

(a) to resist extra shear force due to live load.

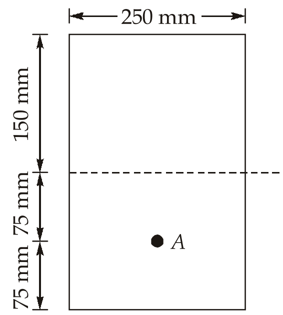
(b) to resist the effect of shrinkage of concrete.

(c) to prevent abrupt formation of inclined cracks in lightly reinforced beams.

(d) to resist shear cracks at the bottom of beam.

197. (c)

Q.198 In the prestressed concrete beam section shown in the given figure, if the net losses are 15% and final prestressing force applied at '*A*' is 500 kN, the initial extreme fibre stresses at top and bottom will be respectively



(a) –3.40 N/mm² and 16.70 N/mm² (b) –3.40 N/mm² and 19.60 N/mm²

(c) –3.92 N/mm² and 16.70 N/mm² (d) –3.92 N/mm² and 19.60 N/mm²

198. (d)

Loss of prestress $P_L(\%) = 15$

Final prestressing force = 500 kN

Initial prestressing force, $$P = \frac{500}{\left(1-\frac{15}{100}\right)} = 588.24 \text{ kN}$$

$e = 75$ mm.

Area of beam, $A = 250 \times 300 = 75000 \text{ mm}^2$

Top fiber stress $$= \frac{P}{A}\left(1-\frac{6e}{d}\right) = \frac{588.24\times10^3}{75000}\left(1-\frac{6\times75}{300}\right)$$

$= -3.92 \text{ N/mm}^2$

Bottom fiber stress $$= \frac{P}{A}\left(1+\frac{6e}{d}\right) = \frac{588.24\times10^3}{75000}\left(1+\frac{6\times75}{300}\right)$$

$= 19.6 \text{ N/mm}^2$

Q.199 A square column of 280 mm × 280 mm cross-section has main longitudinal reinforcement of 40 mm diameter. The minimum spacing of the lateral ties as per **IS 456:2000** is

(a) 280 mm (b) 300 mm

(c) 150 mm (d) 640 mm

199. (a)

Minimum spacing of the lateral ties,

$$S_v = \left.\begin{matrix} D \\ 16\phi_{\text{long,min}} \\ 300\,\text{mm} \end{matrix}\right\} \begin{matrix} 280\,\text{mm} \\ = 16\times 40 = 640\,\text{mm} \\ 300\,\text{mm} \end{matrix} \Bigg\}\text{whichever is less}$$

Q.200 Consider the following statements about flat slab as per IS 456 : 2000:

1. The term 'flat slab' means a reinforced concrete slab with or without drops, supported generally without beams, by columns with or without flared column heads.
2. The minimum thickness of flat slab shall be 125 mm.
3. The critical section for shear shall be at a distance $d/2$ from the periphery of the column/capital/drop panel.
4. The spacing of bars in a flat slab, shall not exceed 2 times the slab thickness.

Which of the above statements are CORRECT?

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

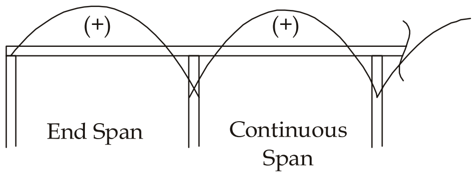
200. (d)

Q.201 For a continuous slab, factored loading is given as:

Fixed type imposed load of 1.5 kN/m^2, non-fixed type imposed load of 2.5 kN/m^2, self weight of 3.5 kN/m^2. If the effective span is 5 m then maximum positive bending moment in interior span will be

(a) 19.53 kNm (b) 16.67 kNm
(c) 13.02 kNm (d) 20.32 kNm

201. (c)



Fixed load, $+\frac{1}{12}$ $+\frac{1}{16}$

Non fixed load $+\frac{1}{10}$ $+\frac{1}{12}$

Fixed load, $w_f = 3.5 + 1.5 = 5\ \text{kN/m}^2$

Non fixed load, $w_{nf} = 2.5\ \text{kN/m}^2$

$$M_{u,\max}(+) = \frac{1}{16}w_f L^2 + \frac{1}{12}w_{nf}L^2$$

$$= \frac{1}{16}\times 5\times 5^2 + \frac{1}{12}\times 2.5\times 5.0^2 = 13.02\ \text{kNm}$$

Q.202 For a RCC beam reinforced with Fe500 steel, minimum and maximum percentage of tension reinforcement respectively are:

(a) 0.17, 4
(b) 0.15, 4
(c) 0.12, 4
(d) 0.25, 6

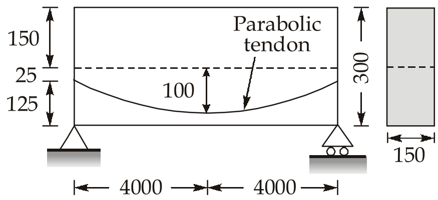
202. (a)

Minimum tension reinforcement,

$$\frac{A_{st,min}}{bd}\times 100 = \frac{0.85}{f_y}\times 100 = \frac{0.85}{500}\times 100 = 0.17\%$$

Maximum tension reinforcement = 4%

Q.203 In the PSC beam shown, f_{ck} = 45 MPa and it supports a UDL of 15 kN/m including self weight. It is prestressed by a parabolic cable carrying an effective prestress of 200 kN. The shear resistance of uncracked section at the support will be



All dimensions are in mm

(a) 93.8 kN
(b) 94.5 kN
(c) 94.2 kN
(d) 95.4 kN

203. (b)

Slope of the cable at supports,

$$\theta = \frac{4(e_0 - e_s)}{L}$$

$$e_0 = 100 \text{ mm}$$

$$e_s = 25 \text{ mm}$$

$$\therefore \quad \theta = \frac{4\times(100-25)}{8000}$$

$$= 0.0375 \text{ radians}$$

Vertical component of prestressing force at support = 200 × 0.0375 = 7.5 kN

As per **IS:1343-1980** the ultimate resistance of a section uncracked in flexure is

$$V_{co} = 0.67bD\sqrt{f_t^2 + 0.8 f_{cp} f_t}$$

Maximum principal tensile stress,

$$f_t = 0.24\sqrt{f_{ck}} = 0.24\times\sqrt{45} = 1.61 \text{ N/mm}^2$$

$$b = 150 \text{ mm}$$

$$D = 300 \text{ mm}$$

Compressive stress at centroidal axis,

$$f_{cp} = \frac{P}{bD} = \frac{200\times 10^3}{150\times 300} = 4.44 \text{ N/mm}^2$$

$\therefore \quad V_{co} = 0.67 \times 150 \times 300 \times\sqrt{(1.61)^2 + 0.8\times 1.61\times 4.44}$

$= 86918 \text{ N} = 86.9 \text{ kN}$

$\therefore$ Shear resistance = 86.9 + 7.5

$= 94.4$ kN

Q.204 A cantilever steel beam of 3 m span carries a uniformly distributed factored load of 20 kN/m inclusive of self weight. The beam comprises ISLB 200@ 198 N/mm having flange 100 mm × 7.3 mm, web thickness 5.4 mm,
$I_{xx} = 1696.6 \text{ cm}^4$, $I_{yy} = 115.4 \text{ cm}^4$
Bending and shear stresses in the beam are respectively
(a) 530.47 N/mm^2 and 55.56 N/mm^2 (b) 3899.48 N/mm^2 and 56.56 N/mm^2
(c) 132.62 N/mm^2 and 41.1 N/mm^2 (d) 1949.74 N/mm^2 and 41.10 N/mm^2

204. (a)

The maximum bending moment, $M = \frac{wl^2}{2} = \frac{20\times 3^2}{2} = 90$ kN-m

Section modulus of beam, $Z = \frac{I_{xx}}{(200/2)} = \frac{1696.6\times 10^4}{100} = 1696.6 \times 10^2 \text{ mm}^3$

Bending stress, $\sigma = \frac{M}{Z} = \frac{90\times 10^6}{1696.6\times 10^2} = 530.47 \text{ N/mm}^2$

Maximum shear force, $V = \frac{wl}{2} = \frac{20\times 3}{2} = \frac{60}{2} \text{ kN} = 30 \text{ kN}$

Shear stress, $\tau = \frac{V}{t_w \times d}$

Thickness of web, $t_w = 5.4$ mm

$\therefore \quad \tau = \frac{30\times 10^3}{5.4\times 200} = 27.78 \text{ N/mm}^2$

Q.205 The gauge length should not be more than (Both in compression and tension)
(a) 4t or 200 mm (b) 100 + 4t or 200 mm
(c) 12t or 200 mm (d) 100 + 12t or 200 mm

205. (b)

As per **IS 800 : 2007** (Clause 10.2.3.3) the distance between the centres of any two consecutive fasteners in a line adjacent and parallel to an edge of an outside plate (i.e. gauge distance) shall not exceed 100 mm + 4t or 200 mm, whichever is less.

Q.206 Purlins are to be chosen for a roof truss of 20 m span, 4 m rise. Trusses are spaced at 4.5 m centre-to-centre. A most efficient design results from the use of
(a) angle sections (b) channel section
(c) circular hollow sections (d) square hollow sections

206 (b)

Channel section is preferable for easy fastening advantage (over hollow section) and for more strength (over angle section).

Q.207 Match **List-I** with **List-II** and select the correct answer using the codes given below the lists:

List-I

A. Maximum pitch of fasteners or welds in compression zone.

B. Maximum pitch of fasteners or welds in tension zone.

C. Maximum pitch of fasteners in compression, if they are staggered $(g \ngtr 75)$.

D. Maximum pitch of fasteners in tension, if they are staggered $(g \ngtr 75)$.

List-II

1. 16 t

2. 12 t

3. 24 t

4. 18 t

Where 't' is thickness of the member.

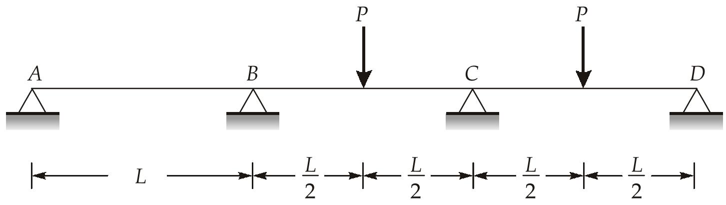
Codes:

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

207. (d)

Maximum pitch is increased by 50% if bolts are staggered $(g \ngtr 75)$ both in tension and compression.

Q.208 A continuous beam is loaded as shown in the figure below. Assuming the plastic moment capacity equal to M_P, the minimum load at which the beam will collapse is



(a) $\frac{4M_P}{L}$

(b) $\frac{6M_P}{L}$

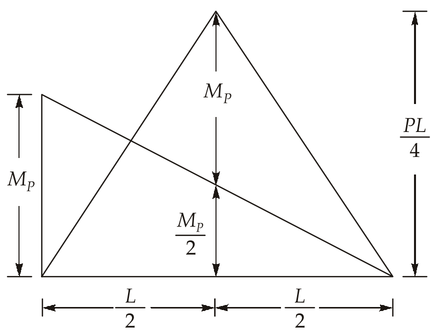
(c) $\frac{8M_P}{L}$

(d) $\frac{10M_P}{L}$

208. (b)

Using static theorem,

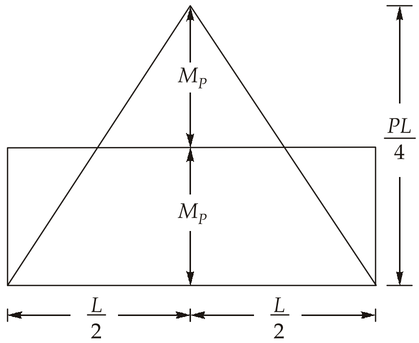
For collapse in CD



$$M_p + \frac{M_p}{2} = \frac{PL}{4}$$

$$\Rightarrow \quad P = \frac{6M_p}{L}$$

For collapse in BC



$$M_P + M_P = \frac{PL}{4}$$

$$\Rightarrow \quad P = \frac{8M_p}{L}$$

$$\therefore \quad \text{Minimum load for collapse} = \frac{6M_p}{L}$$

Q.209 For a fixed beam loaded with UDL (w kN/m), the value of load required to form plastic hinges at ends only is [M_P = Plastic moment of resistance]

(a) $\frac{24M_P}{L^2}$ (b) $\frac{16M_P}{L^2}$

(c) $\frac{18M_P}{L^2}$ (d) $\frac{12M_P}{L^2}$

209. (d)

When two hinges are formed at ends, beam has not collapsed yet.

Hence fixed end moments will be there at ends,

$$\therefore \quad M_P = \frac{wL \times L}{12}$$

$$\Rightarrow \quad w = \frac{12M_P}{L^2}$$

Q.210 Consider the following statements:

1. Torsional restraint prevents rotation of the beam about its longitudinal axis.
2. Effective length of compression flange depends only on torsional restraint.
3. Warping restraint prevents rotation of flange in its plane.

Which of the following statements are CORRECT?

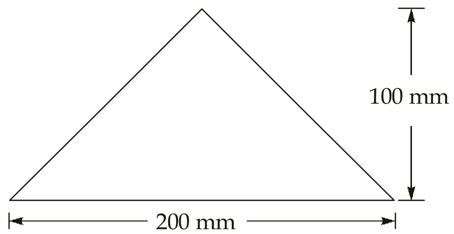
(a) 1 and 2 (b) 2 and 3

(c) 1 and 3 (d) 1, 2 and 3

210. (c)

Effective length of compression flange depends upon both torsional and warping restraints.

Q.211 When the triangular section of a beam as shown below becomes a plastic hinge, the compressive force acting on the section (with yield stress = 250 MPa) becomes



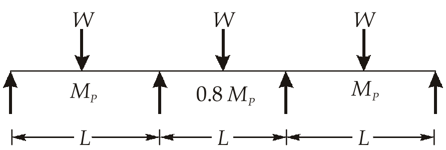
(a) 1666 kN
(b) 1250 kN
(c) 2500 kN
(d) 1111 kN

211. (b)

Neutral axis of a plastified section is the equal area axis.

So, compressive force $= \frac{\sigma_y A}{2} = 250 \times \frac{\frac{1}{2} \times 100 \times 200}{2}$ N = 1250 kN

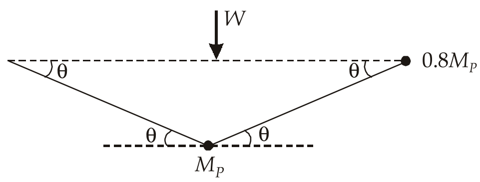
Q.212 The figure below shows a continuous beam loaded with concentrated loads W at the centre of each span. The value of W at collapse will be



(a) $3.2\ M_p/L$
(b) $4\ M_p/L$
(c) $5.6\ M_p/L$
(d) $6.4\ M_p/L$

212. (c)

Failure in the left/right span can be caused by formation of two hinges.



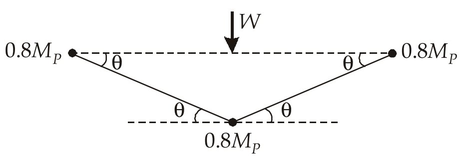
Left/Right span

Using virtual work method

$$W \times \frac{L\theta}{2} = M_p(2\theta) + 0.8M_p\theta$$

$$W = \frac{5.6M_p}{L}$$

The failure in the middle span will be caused by formation of three hinges.



$$\frac{WL\theta}{2} = 0.8M_p(\theta + 2\theta + \theta)$$

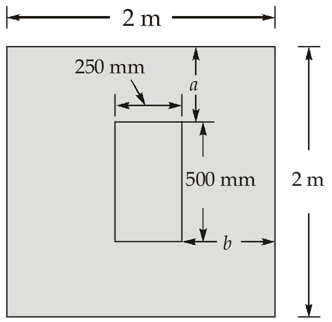
$$W = \frac{6.4M_P}{L}$$

The lower load $\frac{5.6M_P}{L}$ will be taken as the collapse load.

Q.213 A square steel slab base of area 4 m^2 is provided for a column made of two rolled channel sections. The 500 mm × 250 mm column carries an axial compressive load of 2500 kN. The line of action of the load passed through the centroid of the column section as well as of the slab base. The required minimum thickness (in mm) of the slab base as per **IS 800:2007** is
[Take f_y = 250 N/mm^2]

(a) 45
(b) 54
(c) 64
(d) 75

213. (c)



500 mm × 250 mm column leaves projections as

$$a = \frac{2000-250}{2} = 875 \text{ mm} \quad \text{and} \quad b = \frac{2000-500}{2} = 750 \text{ mm}$$

Pressure on the underside of base slab

$$= \frac{2500}{4} = 625 \text{ kN/m}^2 = 0.625 \text{ N/mm}^2$$

Thick of slab base, $t = \sqrt{2.5w\left(a^2-0.3b^2\right)\left(\frac{\gamma_{m0}}{f_y}\right)} = \sqrt{2.5\times0.625\left(875^2-0.3\times750^2\right)\times\frac{1.1}{250}}$

$\simeq$ 64 mm

Q.214 The design compressive stress of an axially loaded compression member is given by,

$$f_{cd} = \chi\frac{f_y}{\gamma_{m0}}$$

where χ is the stress reduction factor which is expressed as

(a) $\frac{1}{\left(\phi-\left(\lambda^2-\phi^2\right)^{0.5}\right)}$
(b) $\frac{1}{\left(\phi+\left(\phi^2-\lambda^2\right)^{0.5}\right)}$
(c) $\phi+\left(\phi^2-\lambda^2\right)^{0.5}$
(d) $\frac{1}{\lambda+\left(\phi^2-\lambda^2\right)^{0.5}}$

214. (b)
Ref IS code 800 : 2007, Clause 7.1.2.1

Q.215 As per **IS 800:2007** specifications the beam sections should be
(a) atleast symmetrical about one of the principal axes.
(b) preferably plastic or compact sections only
(c) rolled to furnish maximum sectional modulus
(d) All of the above

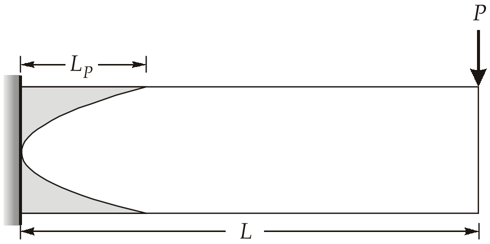
215. (d)

Q.216 A compression member provided with battens carries a factored axial force of 100 kN. The battens shall be designed to carry a transverse shear equal to
(a) 2.5 kN
(b) 1.25 kN
(c) 1.75 kN
(d) 2.25 kN

216. (a)
Battens are designed to carry transverse shear which is equal to

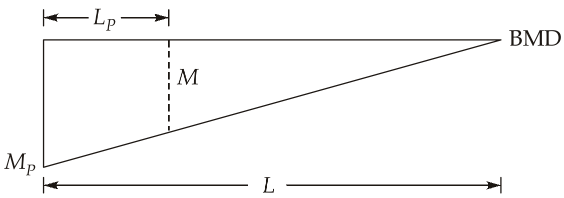
$$2.5\% \text{ of axial factored load} = 2.5 \times \frac{100}{100} = 2.5 \text{ kN}$$

Q.217 A cantilever beam of length L and a cross-section with shape factor 1.5 supports a concentrated load P as shown below



The length of plastic zone, when the maximum bending moment, equals the plastic moment M_p, is given by
(a) 0.67 L
(b) 0.33 L
(c) 0.182 L
(d) 0.44 L

217. (b)



So, from similar triangles,

$$\frac{M_P}{M} = \frac{L}{L - L_P} = \text{Shape factor} = 1.5$$

$$\Rightarrow \quad L = 1.5\,L - 1.5\,L_P$$

$$\Rightarrow \quad 1.5\,L_P = 0.5\,L$$

$$\Rightarrow \quad L_P = \frac{1}{3}L$$

Q.218 A single lacing system is inclined at 45° with the axis of column. Column is carrying a factored axial load of 1200 kN. Lacing is connected by 20 mm diameter bolt and thickness of lacing bar is 12 mm. Tensile stress in each lacing bar will be

(a) 150 MPa
(b) 108 MPa
(c) 62 MPa
(d) 46.5 MPa

218. (d)

$\because$ 20 mm bolt are used

$\therefore$ Minimum width of lacing bar for 20 mm diameter bolt = 60 mm (From IS 800 : 2007)

Transverse shear on lacing, $V = \frac{2.5}{100} \times 1200 = 30 \text{ kN}$

Force on each lacing bar, $F = \frac{V}{2\sin 45°} = \frac{30 \times 1.414}{2} = 21.21 \text{ kN}$

Tensile stress in each lacing bar $= \frac{21.21 \times 10^3}{(60-22) \times 12} = 46.50 \text{ MPa}$

Q.219 Gantry girders can be designed

1. for use in multistorey buildings.
2. as laterally unsupported beams.
3. using channel sections only.

Which of the above statement/s is/are CORRECT?

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

219. (b)

Gantry girders are designed as laterally unsupported beams and are used in industrial buildings.

Q.220 As per **IS 800 : 2007**, which of the following is the partial factor of safety for a friction type bolt having field fabrication?

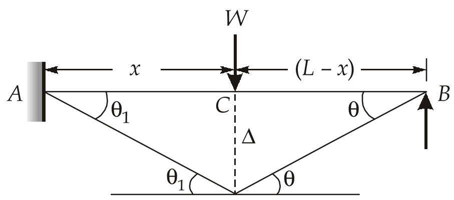
(a) 1.10
(b) 1.15
(c) 1.25
(d) 1.50

220. (c)

Q.221 A beam of uniform cross-section and span L is built-in at one end and simply supported at the other. It carries a point load at a distance x from the built-in end. The collapse load has the value of

(a) $\frac{2L}{2L-x} M_P$
(b) $\frac{2x-L}{x(x-L)} M_P$
(c) $\frac{2L-x}{x(L-x)} M_P$
(d) $\frac{2x-L}{L(L-x)} M_P$

221. **(c)**



$$\Delta = x\theta_1 = (L-x)\theta$$

$$\text{Internal work done} = M_P\theta_1 + M_P(\theta_1+\theta)$$

$$= M_P\left(\frac{L-x}{x}\right)\theta + M_P\left(\frac{L-x}{x}\theta+\theta\right)$$

$$= M_P\left(\frac{L-x}{x}+\frac{L-x}{x}+1\right)\theta$$

$$= M_P\left(\frac{2L-x}{x}\right)\theta$$

Now, External workdone = Internal work done

$$\Rightarrow \quad W_u(L-x)\theta = M_P\left(\frac{2L-x}{x}\right)\theta$$

$$\Rightarrow \quad W_u = \frac{2L-x}{x(L-x)}M_P$$

Q.222 A flat tie 200 ISF 20 is carrying tensile load. There is a possible reversal of stress in the member due to loads other than winds or seismic loading. The limiting length of flat as per IS 800 will be

(a) 820 mm
(b) 940 mm
(c) 1040 mm
(d) 980 mm

222. **(c)**

A tension member in which reversal of direct stress occurs due to load other than wind or seismic loading

$$\frac{l_{max}}{r_{min}} \le 180$$

$$\text{Limiting slenderness ratio} = \frac{l_{max}}{r_{min}} \le 180$$

l_{max} = Limiting length of flat tie

r_{min} = Minimum radius of gyration of flat

$$r_{min} = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{bt^3/12}{bt}} = \frac{t}{\sqrt{12}} = \frac{20}{\sqrt{12}} = 5.7735 \text{ mm}$$

Limiting length of flat tie, $l_{max} = 180 \times 5.7735 = 1039.23$ mm ≈ 1040 mm

Q.223 Which of the following statements are correct regarding high strength friction grip bolt?
1. Load is transmitted by friction only.
2. Bolts generally are not subjected to shearing and bearing.
3. Connection with HSFG bolts have more rigidity than welded connections.

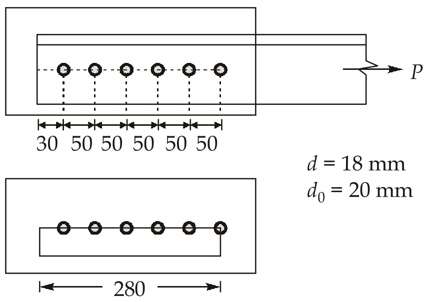
(a) 1 and 3 only (b) 1 and 2 only
(c) 2 and 3 only (d) 1, 2 and 3 only

223. (b)

Q.224 A single angle of thickness 10 mm is connected to a gusset by 6 M18 bolts of grade 4.6 with pitch of 50 mm and width edge distance of 30 mm. The net area in block shear along the line of the transmitted force is

(a) 1700 mm^2 (b) 1840 mm^2
(c) 1920 mm^2 (d) 1940 mm^2

224. (a)



(All dimensions are in mm)

Diameter of bolt = ϕ = 18 mm. diameter of bolt hole = 20 mm

$$\text{Net area of block shear} = \left(280 - 5 \times 20 - \frac{20}{2}\right) \times 10 = 1700 \text{ mm}^2$$

Q.225 An unequal angle section is used as tension member in the truss. Maximum length that can be provided for the member always under tension will be
[Take: Properties of angle section I_{uu} = 6 × 10^6 mm^4, I_{vv} = 5 × 10^6 mm^4, Area = 2000 mm^2]

(a) 17.5 m (b) 9 m
(c) 20 m (d) 12 m

225. (c)

$$r_{min} = \sqrt{\frac{I_{min}}{A}} = \sqrt{\frac{5 \times 10^6}{2000}} = 50 \text{ mm}$$

$\lambda = \dfrac{l_{eff}}{r_{min}}$, where λ = 400 for member always under tension ...(Table 3, IS 800:2007)

$\therefore$ $$400 = \frac{l_{eff}}{50}$$

$\Rightarrow$ l_{eff} = 400 × 50 mm = 20000 mm = 20 m

Direction: The following items consists of two statements, one labelled as **Statement (I)** and the other labelled as **Statement (II)**. You have to examine these two statements carefully and select your answers to these items using the codes given below:

Codes:

(a) Both Statement (I) and Statement (II) are true and Statement (II) is the correct explanation of Statement (I).
(b) Both Statement (I) and Statement (II) are true but Statement (II) is not a correct explanation of Statement (I).
(c) Statement (I) is true but Statement (II) is false.
(d) Statement (I) is false but Statement (II) is true.

Q.226 Statement (I): The block shear failure occurs along a path involving tension on one plane and shear on a perpendicular plane.

Statement (II): The total strength equals the fracture strength of the stronger plane plus the yield strength of weaker plane.

226. (b)

Q.227 Statement (I): The development length for M25 concrete and HYSD Fe415 bars is more than that for mild steel plain bars.

Statement (II): The permissible bond stress for HYSD Fe415 bars is more than that for mild steel plain bars.

227. (a)

Development length, $L_d = \dfrac{\phi\sigma_s}{4\sigma_{bd}}$

L_d for mild steel and M25 concrete $= \dfrac{0.87(250)\phi}{4(1.4)} = 38.8\phi$

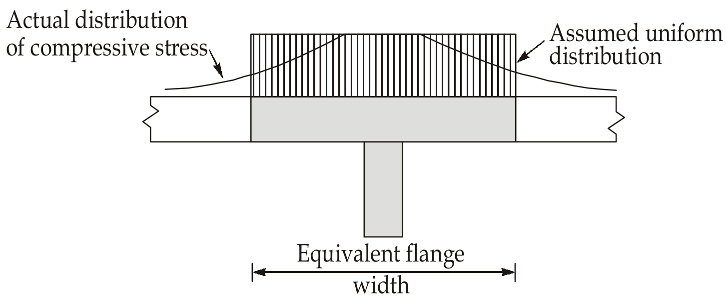
L_d for Fe415 and M25 concrete $= \dfrac{0.87(415)\phi}{4(1.6\times1.4)} = 40.3\phi$

So L_d (Fe415) > L_d (Fe250).

Q.228 Statement (I): In case of flanged section, effective width of flange is considered for moment calculation purpose.

Statement (II): Flexural compressive stresses are not uniform over its width.

228. (a)



Q.229 Statement(I): In a double bolted double cover butt joint, no bending stress is developed.
Statement (II): In a single cover butt joint, bending stress may develop leading to distortion of the joint.

229. (b)

Q.230 Statement (I): Unequal angles with short legs connected are more efficient for tension member.
Statement (II): Outstanding leg should be as small as possible because shear lag affects its capacity.

230. (d)
Unequal angles with long legs connected are more efficient for tension member.

■■■■

