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Important Questions *for* GATE 2022

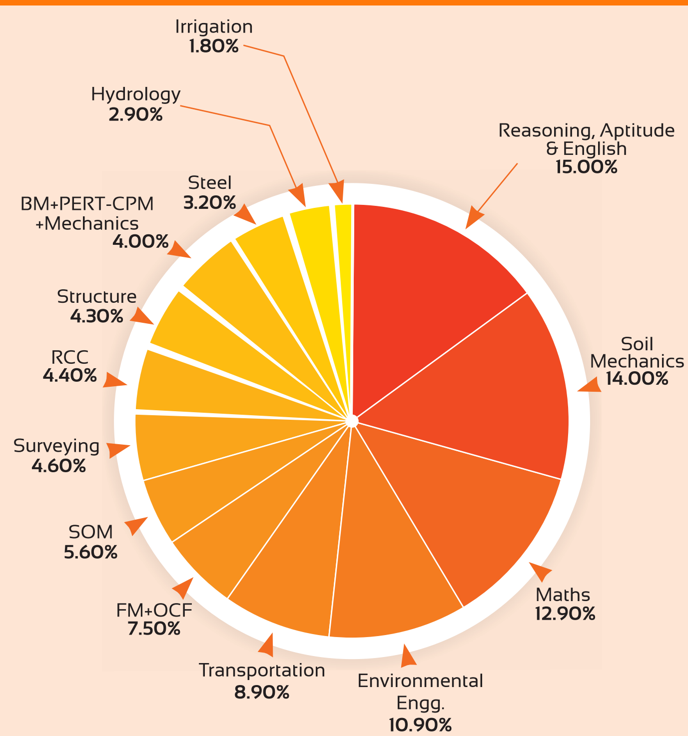
CIVIL ENGINEERING

Day 3 of 8

Q.51 - Q.75 (Out of 200 Questions)

Solid Mechanics + RCC Structures and Prestressed Concrete

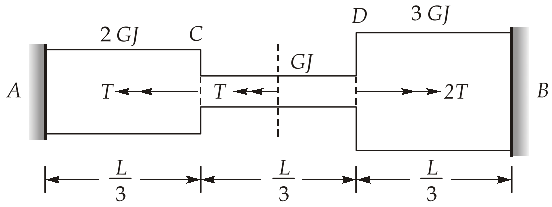
SUBJECT-WISE WEIGHTAGE ANALYSIS OF GATE SYLLABUS



Subject	Average % (last 5 yrs)
Reasoning, Aptitude and English	15.00%
Soil Mechanics	14.00%
Engineering Mathematics	12.90%
Environmental Engineering	10.90%
Transportation Engineering	8.90%
Fluid Mechanics + OCF	7.50%
Strength of Materials	5.60%
Surveying Engineering	4.60%
Reinforced Cement Concrete	4.40%
Structural Analysis	4.30%
Building Materials+PERT-CPM+Mechanics	4.00%
Steel Structures	3.20%
Engineering Hydrology	2.90%
Irrigation Engineering	1.80%
Total	**100%**

Solid Mechanics + RCC Structures and Prestressed Concrete

Q.51 A stepped circular shaft fixed at both the ends is loaded as shown in figure, then the reaction torque at end A is



(a) $\frac{10T}{11}$ (b) $\frac{12T}{11}$

(c) $\frac{18T}{17}$ (d) $\frac{14T}{11}$

Q.52 A solid circular shaft has a uniform diameter of 0.0508 m and is 3.048 m long. At its midpoint, 65 hp is delivered to the shaft by means of a belt passing over a pulley. This power is used to drive two machines, one at the left end of the shaft consuming 25 hp and one at the right end consuming 40 hp. The shaft turns at 200 rev/min, then the maximum shear stress (in MPa, correct upto two decimal places) developed in the shaft will be
[Take G = 82.74 GPa and assume elastic action]

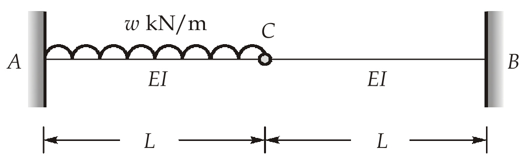
Q.53 If the area of cross-section of a circular beam is made four times, keeping the loads, length, support conditions and material of the beam unchanged, then the quantities (List I) will change through different factors (List II). Match the **List I** with **List II** and select the correct answer using the codes given below the lists:

List-I	List-II
A. Maximum bending moment	**1.** 8
B. Deflection	**2.** 1
C. Bending stress	**3.** 1/8
D. Section modulus	**4.** 1/16

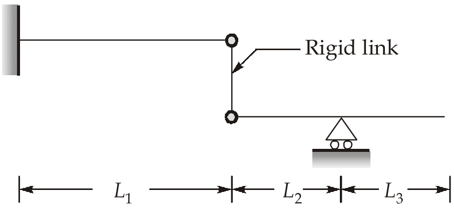
Codes:

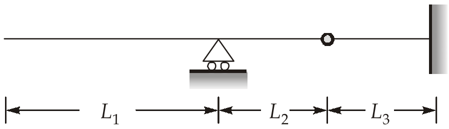
	A	B	C	D
(a)	2	4	3	1
(b)	3	1	2	4
(c)	2	1	3	4
(d)	3	4	2	1

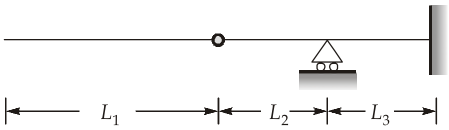
Q.54 The reaction on the pin C for a beam as shown in the figure below is ________ wL N.

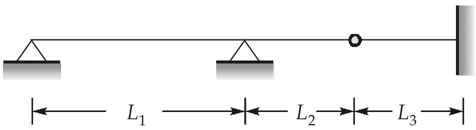


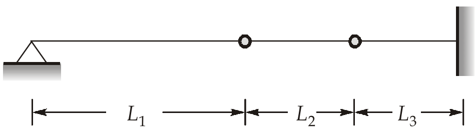
Q.55 For the beam as shown in figure given below, which among the following is the conjugate beam?



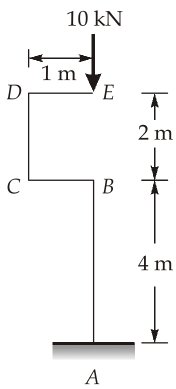
(a)


(b)


(c)


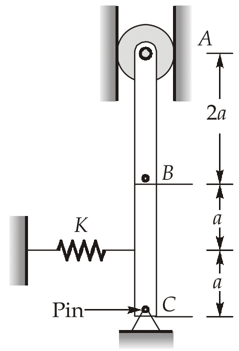
(d)


Q.56 What is the bending moment (in kN-m) at A for the bent column as shown in the figure given below?



(a) Zero
(b) 10
(c) 20
(d) 40

Q.57 Two identical rigid bars *AB* and *BC* are pinned at *B* and *C* supported at *A* by a pin in a frictionless roller that can only displace vertically, then the critical load of the system will be



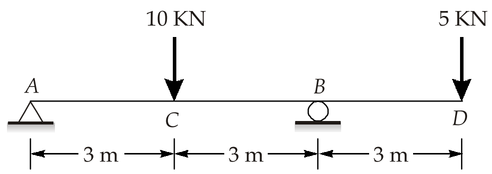
(a) $\frac{ka}{2}$

(b) $\frac{ka}{4}$

(c) $\frac{ka}{8}$

(d) None of these

Q.58 For the beam loaded as shown in figure given below, if the slope at *A* is $\frac{7.5}{EI}$, then the deflection at *C* will be



(a) $\frac{11.25}{EI}$

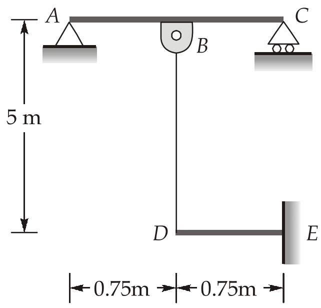
(b) $\frac{22.50}{EI}$

(c) $\frac{37.50}{EI}$

(d) None of these

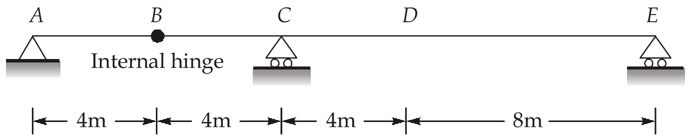
Q.59 A steel bar 50 cm long and 3 cm × 1 cm in cross-section, when it is subjected simultaneously to an axial pull of 50 kN and compressive stress of 100 N/mm^2 on its narrow edge, then the strain energy stored in a steel bar (in J, correct upto 1 decimal place) is
[Take $E = 2 \times 10^5$ N/mm^2 and $\mu = 0.25$]

Q.60 A steel wire 5 m long and of cross-sectional area 156 mm^2 is fitted tightly between the midpoint of a simply supported beam and the free end of a cantilever beam as shown in figure. The force developed (in N) in wire and its nature due to temperature drop of 30°C is, respectively are: [For steel wire, E = 200 GPa, $\alpha = 12 \times 10^{-6}$ per °C and EI = 85 kNm^2 for both the beams]



(a) 526.39 and tension
(b) 526.39 and compression
(c) 775.41 and tension
(d) 775.41 and compression

Q.61 A beam with internal hinge *B* is shown in figure below. A concentrated moving load of 5 kN and a uniform moving load of 500 N/m is subjected to beam together.



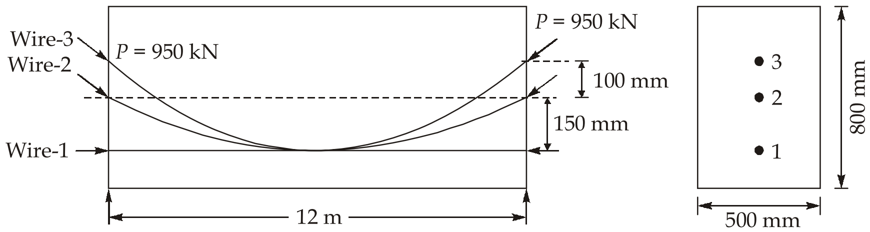
The maximum positive bending moment that can be developed at point '*D*' in the beam is __________ kNm.
[Consider self weight of beam = 300 N/m]

Q.62 A beam is subjected to an axial compressive force of 100 kN along with the transverse loading. Maximum shear force in the section is 125 kN, and it has longitudinal tension reinforcement of 900 mm^2. Take M20 grade concrete and Fe415 grade steel. Corresponding to 0.6% of steel the design shear strength of M20 concrete is 0.512 N/mm^2. The design shear strength of given beam (in N/mm^2 correct upto 2-decimal places) is [Use LSM]

Q.63 A beam section of size 400 mm × 600 mm and of span 8 mm is doubly reinforcement as limiting section. Area of reinforcement required in tension side to sustain under live load of 35 kNm will be ________ mm^2. [Take f_{ck} = 20 N/mm^2, f_y = 415 N/mm^2, d_c = 50 mm, effective cover = 50 mm]
(a) 1745 mm^2
(b) 1196 mm^2
(c) 3000 mm^2
(d) 3898 mm^2

Q.64 An isolated footing of size 4 m × 4 m supports square column of size 500 mm × 500 mm. The column is subjected to 3000 kN service load. Assume M 20 grade concrete for footing and M 25 grade concrete for the column. The bearing resistance of concrete at column footing interface is _________ kN.

Q.65 A post tensioned PSC beam shown in figure.

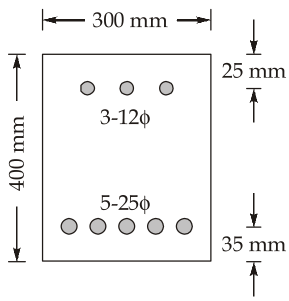


The loss of stress due to elastic shortening in wire-3 will be _______ N/mm^2. [upto 2 decimal points] if wire tensioned subsequently and wire-3 tensioned first.

Q.66 A cantilever beam of width 450 mm and effective depth 600 mm is laterally restrained at a distance L from the free end. The maximum value of 'L' to ensure proper lateral stability is _______ m.

Q.67 In limit state design, a doubly reinforced beam is subjected to ultimate shear force of 240 kN. Adopt 12 mm diameter 2 legged shear stirrups and Fe500 grade of steel. The value of design shear strength of concrete, τ_c for M20 grade are as given in table below:

p_t (%)	τ_c (N/mm^2)
2.00	0.79
2.25	0.81
2.50 & greater	0.82



The spacing of vertical shear stirrups is
(a) 145 mm (b) 167 mm
(c) 197 mm (d) 245 mm

Q.68 A prestressed concrete pile, 250 mm square contains 60 pre-tensioned wire, each of 2 mm diameter, uniformly distributed over the section. The wires are initially tensioned with a total force of 300 kN.
Given, E_s = 2.1 × 10^5 N/mm^2 and E_c = 3.2 × 10^4 N/mm^2, shrinkage strain of concrete = 200 × 10^{-6} and creep coefficient = 1.6.
Consider the following statements:
(i) Loss of stress due to elastic deformation is 31.5 N/mm^2
(ii) Loss of stress due to creep of concrete = 50.38 N/mm^2
(iii) Loss of stress due to shrinkage of concrete = 42 N/mm^2
Which of the above statements are correct?
(a) (i) and (ii) (b) (ii) and (iii)
(c) (i) and (iii) (d) (i), (ii) and (iii)

Q.69 A concrete beam is prestressed by a cable carrying an initial prestressing force of 500 kN. The cross-sectional area of the wires in the cable is 500 mm^2. The ratio of percentage loss of stress in the cable due to shrinkage of concrete in pre-tensioned and post-tensioned prestressed beam is __________. [Assume modulus of elasticity of steel (E_s) = 210 kN/mm^2 and age of concrete at transfer = 8 days]

Q.70 If a simply supported concrete beam prestressed with a force of 2500 kN is designed by load balancing concept for an effective span of 10 m and to carry a uniformly distributed load of 40 kN/m (including self weight) then the central dip of the cable profile should be

(a) 100 mm
(b) 300 mm
(c) 200 mm
(d) 400 mm

Q.71 The deflection of prestressed concrete beam is excessive in the

(a) Pre - cracking stage
(b) Plastic stage
(c) Post - cracking stage
(d) None of the above

Multiple Select Questions (MSQ)

Q.72 Which of the following statements are correct?

(a) All load carrying members transmit load through basic modes of tension, compression, torsion and shear only.
(b) Beams carry transverse loads.
(c) Combined loading is a complicated loading.
(d) Nature of internal forces decides the aspect of combined loading.

Q.73 Consider the following statements:

Mohr's Circle is used to determine the stress on an oblique section of a body subjected to

(a) direct tensile stress on one plane accompanied by a shear stress.
(b) direct tensile stresses in two mutually perpendicular directions accompanied by a simple shear stress.
(c) direct tensile stress in two mutually perpendicular directions.
(d) a simple shear stress

Q.74 Consider the following statements:

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 concrete.
(c) Modulus of elasticity of steel.
(d) Geometry of the section.

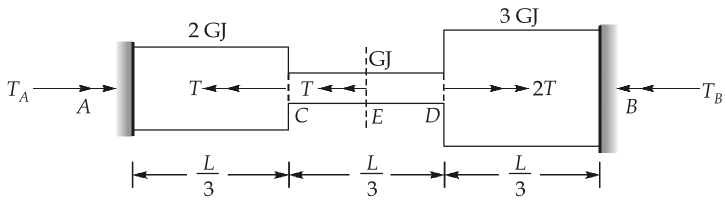
Q.75 Shear strength of concrete in a reinforced concrete beam is a function of which of the following:

(a) Compressive strength of concrete
(b) Percentage of shear reinforcement
(c) Percentage of longitudinal reinforcement in tension in the section
(d) Percentage total longitudinal reinforce-ment in the section

■■■■

Detailed Explanations

51. (c)



From figure since both the ends is fixed

We know that,
$$\theta_{AB} = 0$$
$$\theta_{AC} + \theta_{CE} + \theta_{ED} + \theta_{DB} = 0$$
$$\frac{T_A \cdot L}{6GJ} + \frac{(T_A - T)L}{3GJ} + \frac{(T_A - 2T)L}{3GJ} + \frac{(T_A - 2T + 2T)L}{9GJ} = 0 \qquad \left(\because \theta = \frac{TL}{GJ}\right)$$
$$\Rightarrow \quad \frac{17}{18}T_A = \frac{T}{T_A} = \frac{18T}{17}$$

52. 55.35 (52 - 56)

Torque in left half shaft, $T_1 = \dfrac{746 \times 25}{(200 \times 2\pi / 60)} = 890.47 \text{ N-m} \qquad (\because \quad \omega = 2\pi N/60)$

Torque in right half shaft, $T_2 = \dfrac{746 \times 40}{(200 \times 2\pi / 60)} = 1424.75 \text{ N-m}$

Maximum shear stress, $\tau = \dfrac{Tr}{J}$
$$\tau = \frac{1424.75 \times \left(\dfrac{0.0508}{2}\right)}{\dfrac{\pi}{32}(0.0508)^4} = 55.35 \text{ MPa}$$

53. (a)

As the cross section area of circular beam is increased upto 4 times, then it means that the diameter is increased by two times.

(i) Maximum bending moment does not depend upon the cross sectional property of the beam i.e. $A - 2$.

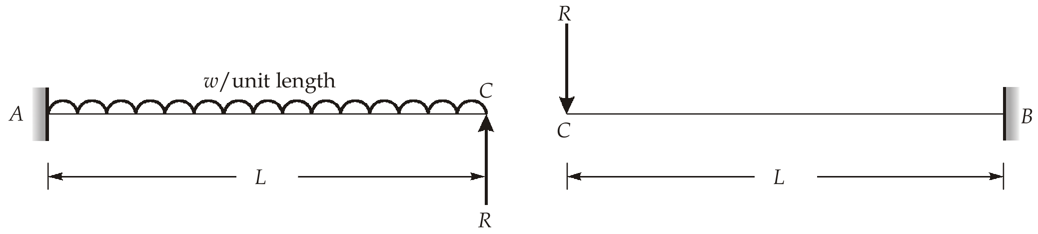
(ii) Deflection $\propto \dfrac{1}{I} \propto \dfrac{1}{A^2}$ i.e. $B - 4$

(iii) Bending stress $\propto \dfrac{1}{I/y} \propto \dfrac{y}{A^2} = \dfrac{1}{8}\left(\dfrac{D/2}{A^2}\right)$ i.e. $C - 3$

(iv) $Z \propto \dfrac{I}{y} \propto \dfrac{A^2}{y} = \dfrac{16}{2}\left(\dfrac{A^2}{D/2}\right) = 8\left(\dfrac{A^2}{D/2}\right)$ i.e. $D - 1$

54. **187.5 (186 - 189)**

Free body diagram of the given beam is shown below



Deflection of point C remains same for beam AC and CB.

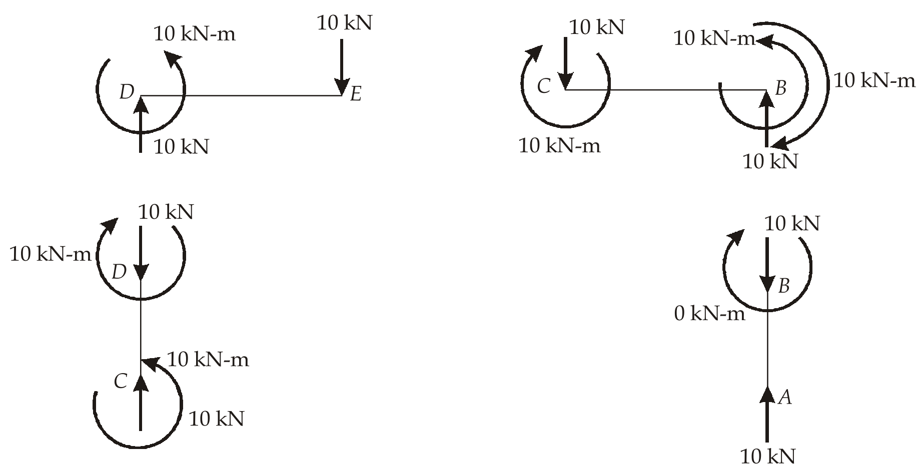
$$\Rightarrow \quad \frac{wL^4}{8EI} - \frac{RL^3}{3EI} = \frac{RL^3}{3EI}$$

$$\Rightarrow \quad \frac{2RL^3}{3EI} = \frac{wL^4}{8EI}$$

$$\Rightarrow \quad R = \frac{3}{16}wL \times 1000 = 187.5wL \text{ N}$$

55. **(a)**

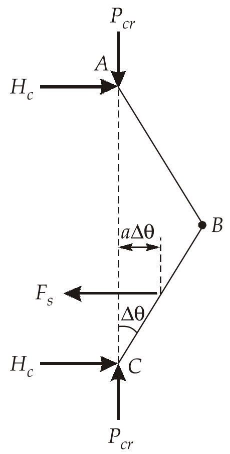
56. **(a)**



$\therefore$ Bending moment at A = 0 kN-m

57. (b)

A free body diagram of the entire system of two rigid bars is shown below



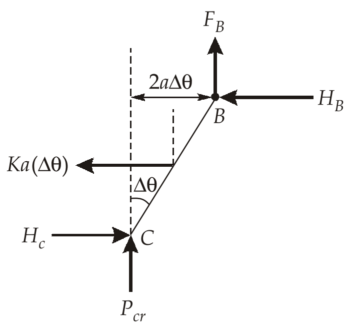
Take, $\Sigma M_A = 0$

$\Rightarrow \quad H_c \times 4a - F_s \times 3a = 0$

$\Rightarrow \quad H_c \times 4a - ka(\Delta\theta) \times 3a = 0$

$\therefore \quad H_c = \dfrac{3ka(\Delta\theta)}{4}$

Now, for the calculation of critical load, consider the free body diagram of lower bar *BC*, shown below

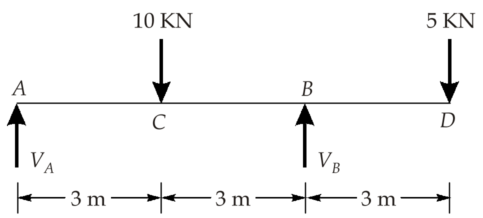


Take, $\Sigma M_B = 0$

$\Rightarrow \quad H_c \times 2a - P_{cr} \times 2a(\Delta\theta) - ka(\Delta\theta) \times a = 0$

$\Rightarrow \quad P_{cr} = \dfrac{ka}{4}$

58. (a)



$$\Sigma F_y = 0$$

$\therefore$ $V_A + V_B = 15$ . . . (i)

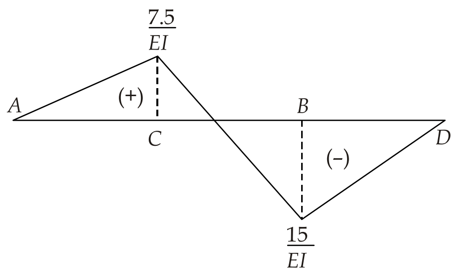
Taking, $\Sigma M_A = 0$

$\Rightarrow$ $10 \times 3 + 5 \times 9 = V_B \times 6$

$\therefore$ $V_B = 12.5$ kN

and $V_A = 2.5$ kN (by using equation (i))

$\frac{M}{EI}$ diagram of the above beam is shown below



From moment area theorem:

$$\Delta_C = \theta_A \times L_{AC} - \delta_{C/A}$$

$$= \frac{7.5}{EI} \times 3 - \left(\frac{1}{2} \times \frac{7.5}{EI} \times 3\right) \times \frac{1}{3} \times 3 = \frac{11.25}{EI}$$

59. 17.3 (17.1 - 17.4)

Strain energy stored will be given as,

$$U = \frac{1}{2E}\left[\sigma_1^2 + \sigma_2^2 - 2\mu\sigma_1\sigma_2\right] \times \text{Volume}$$

where, $\sigma_1 = \frac{50 \times 10^3}{30 \times 10} = 166.67\ \text{N/mm}^2$ (Tensile)

Also, $\sigma_2 = -100\ \text{N/mm}^2$ (i.e. compressive)

$\Rightarrow$ $$U = \frac{1}{2 \times 2 \times 10^5}\left[(166.67)^2 + (-100)^2 - 2 \times 0.25 \times 166.67 \times (-100)\right] \times (500 \times 30 \times 10)$$

$\therefore$ $U = 17292$ N-mm $= 17.29$ J $\simeq 17.3$ J

60. (c)

Contraction of steel wire $= L\,\alpha\,\Delta T$

$= 5 \times 10^3 \times 12 \times 10^{-6} \times 30 = 1.8$ mm

Let, P be the force developed in wire due to contraction

$\therefore$ $$\frac{Pl_1^3}{48EI} + \frac{Pl_2^3}{3EI} - \frac{Pl}{AE} = 1.8 \times 10^{-3}$$

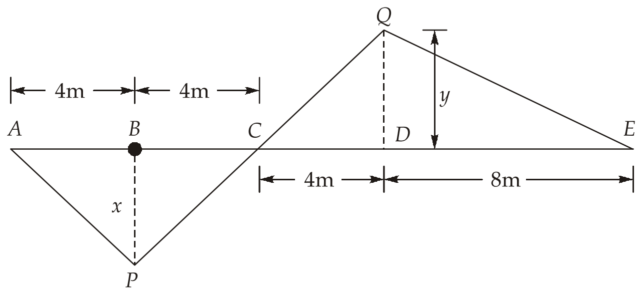
$$\frac{P}{EI}\left[\frac{l_1^3}{48} + \frac{l_2^3}{3}\right] - \frac{Pl}{AE} = 1.8 \times 10^{-3}$$

$$\Rightarrow \quad \frac{P}{85\times10^3}\left[\frac{(1.5)^3}{48}+\frac{(0.75)^3}{3}\right]-\frac{P\times5}{156\times2\times10^5} = 1.8\times10^{-3}$$

$$\therefore \quad P = 775.41 \text{ N (tension)}$$

61. 22.96 (22 - 24)

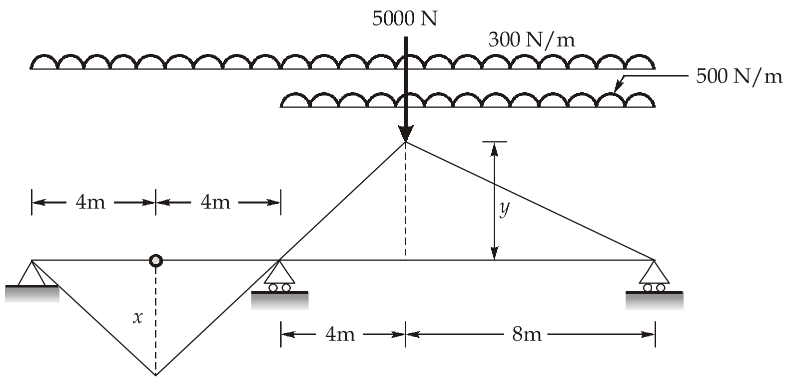
ILD for moment M_D →



Ordinate 'y' →

$$y = \frac{a(l-a)}{l} = \frac{4\times8}{12} = 2.67$$

In ΔBPC and ΔCQD, $\quad x = y = 2.67$



$$M_{D_{max}} = 5000\times2.67+500\times\frac{1}{2}\times12\times2.67+300\times\frac{1}{2}\times12\times2.67-300\times\frac{1}{2}\times8\times2.67$$

$$M_{D_{max}} = 22.96 \text{ kNm}$$

62. 0.56 (0.54 - 0.58)

$$A_{st} = 900 \text{ mm}^2$$

$$p_t = 0.6\%$$

$$0.6 = \frac{A_{st}}{A_g}\times100$$

$$A_g = 150000 \text{ mm}^2$$

Design shear strength of M20 concrete = 0.512 MPa.

As per IS 456:2000 Clause 40.2.2,

for members subjected to axial compression only, the design shear strength of concrete calculated on the basis of percentage of steel and grade of concrete is multiplied by the following factor

$$\delta = 1+\frac{3P_u}{A_g \times f_{ck}} = 1+\frac{3\times100\times1000}{300\times500\times20} = 1.1 < 1.5$$

So, design shear strength of beam = 1.1 × 0.512 = 0.5632 MPa.

63. (c))

Dead load = 0.4 × 0.6 × 1 × 25 = 6 kN/m $(x_u)_{\text{lim}}$ = 0.48 d (for 415

Live load = 35 kN/m

Total factored load = 1.5 (6 + 35) = 61.5 kN/m

$$\text{Bending moment (m)} = \frac{wl^2}{8} = \frac{61.5\times8^2}{8} = 492 \text{ kNm}$$

Now, moment resisting for a singly reinforced section (MR_1)

MR_1 = 0.36 f_{ck} B $x_{u\ lim}$ (d – 0.42 $x_{u\ lim}$)

MR_1 = 0.36 × 20 × 400 × 0.48 × 550 × (550 – 0.42 × 0.48 × 550)

MR_1 = 333.87 kNm

MR_2 = Moment has to resist by compression steel = 492 – 333.87

MR_2=158.13

$$A_{st} = \frac{MR_1}{0.87 f_y\left(d-0.42x_{u\text{lim}}\right)} + \frac{MR_2}{0.87 f_y\left(d-d_c\right)}$$

$$A_{st} = \frac{333.87\times10^6}{0.87\times415\times[550-0.42\times0.48\times550]} + \frac{158.13\times10^1}{0.87\times415\times(550-50)}$$

$$A_{st} = 2982 \text{ mm}^2 \simeq 3000 \text{ mm}^2$$

64. 2812.5 (2810 - 2820)

Limiting bearing stress at column footing interface

$$f_{br,\ \max} = 0.45 f_{ck}\sqrt{\frac{A_1}{A_2}}$$

(i) For column face

f_{ck} = 25 MPa

A_1 = A_2 = $(500)^2$mm^2 = 250000 mm^2

$$f_{br,\ \max\ -\ \text{col.}} = 0.45\times25\times\sqrt{\frac{(500)^2}{(500)^2}}$$

= 11.25 MPa

(ii) For footing face

f_{ck} = 20 MPa

A_1 = $(4000)^2$ mm^2

A_2 = $(500)^2$ mm^2

$$\sqrt{\frac{A_1}{A_2}} = \sqrt{\frac{(4000)^2}{(500)^2}} = \frac{4000}{500} = 8 \not> 2$$

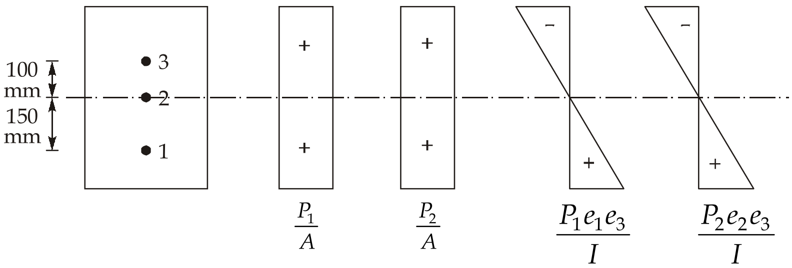
$$\therefore \qquad \sqrt{\frac{A_1}{A_2}} = 2$$

$$\Rightarrow \qquad f_{br,\ max - footing} = 0.45 \times 20 \times 2 = 18 \text{ MPa}$$

Limiting bearing stress is minimum of above two

$$\text{Limiting bearing resistance} = \frac{11.25 \times (500)^2}{1000} = 2812.5 \text{ kN}$$

65. 33.40 (32.00 - 37.00)



At ends: $e_1 = 150$ mm, $e_2 = 0$, $e_3 = 100$ mm

$$f_{c1} = \frac{P_1}{A} + \frac{P_2}{A} - \frac{P_1 e_1 e_3}{I} - \frac{P_2 e_2 e_3}{I}$$

$$f_{c1} = \frac{950 \times 10^3}{800 \times 500} + \frac{950 \times 10^3}{800 \times 500} - \frac{950 \times 10^3 \times 150 \times 100}{500 \times \frac{800^3}{12}} - \frac{950 \times 10^3 \times 0 \times 100}{500 \times \frac{800^3}{12}}$$

$$f_{c1} = 2.375 + 2.375 - 0.6679 - 0 = 4.0821 \text{ N/mm}^2$$

At mid span: $e_1 = e_2 = e_3 = 150$ mm

$$f_{c2} = \frac{P_1}{A} + \frac{P_2}{A} + \frac{P_1 e_1 e_3}{I} + \frac{P_2 e_2 e_3}{I}$$

$$f_{c2} = 2.375 + 2.375 + 2 \times \frac{950 \times 10^3 \times 150 \times 150}{500 \times \frac{800^3}{12}}$$

$$f_{c2} = 6.75 \text{ N/mm}^2$$

$$\text{Loss of stress} = m(f_c)_{avg}$$

$$= m\left[f_{c_1} + \frac{2}{3}\left(f_{c_2} - f_{c1}\right)\right]$$

$$= 5.7\left[4.0821 + \frac{2}{3}(6.75 - 4.0821)\right]$$

$$= 33.40 \text{ N/mm}^2$$

66. 11.25 (10.75 - 11.50)

As per clause 23.3 of IS 456 : 2000

$$L \leq 25B$$

or

$$\frac{100B^2}{d}$$

} minimum of two

$\Rightarrow \quad L \leq 11.25$ m or 33.75 m

$\therefore \quad L = 11.25$ m

67. (c)

Effective depth, $d = 400 - 35 = 365$ mm

Percentage tension steel, $p_t = \dfrac{100 A_{st}}{bd}$

$$= \frac{100 \times 5 \times \frac{\pi}{4} \times 25^2}{300 \times 365}$$

$$= 2.24\% > p_{t\lim} \left(= 41.61 \frac{f_{ck}}{f_y} \cdot \frac{x_{u\lim}}{d} = 41.61 \times \frac{20}{415}(0.48) = 0.96\% \right)$$

$\therefore$ Doubly reinforced section is required.

Design shear strength of concrete,

$$\tau_c = 0.79 + \frac{0.81 - 0.79}{2.25 - 2.00}(2.24 - 2.00)$$

$\tau_c = 0.8092$ N/mm² [From table for $p_t = 2.24\%$]

Nominal shear stress, $\tau_v = \dfrac{V_u}{bd} = \dfrac{240 \times 10^3}{300 \times 365} = 2.19$ N/mm²

Area of shear stirrups, $A_{sv} = 2 \times \dfrac{\pi}{4} \times 12^2 = 226.19$ mm²

$\therefore$ Spacing of vertical shear stirrups,

$$S_v = \frac{0.87 f_y A_{sv} d}{(\tau_v - \tau_c) bd}$$

$$= \frac{0.87 \times 415 \times 226.19}{(2.19 - 0.8092) \times 300} \simeq 197 \text{ mm} \quad (< 0.75d = 273.75 \text{ mm})$$

68. (d)

Average initial stress in concrete

$$f_c = \left(\frac{300 \times 10^3}{250 \times 250} \right) = 4.8 \text{ N/mm}^2$$

Modular ratio, $m = \dfrac{E_s}{E_c} = 6.56$

Loss due to elastic deformation

$$= \frac{E_s}{E_c} \times f_c = 6.56 \times 4.8$$

$$= 31.488 \text{ N/mm}^2 \simeq 31.5 \text{ N/mm}^2$$

Loss due to creep of concrete

$$\phi m f_c = 1.6 \times 6.56 \times 4.8 = 50.381 \text{ N/mm}^2 \simeq 50.38 \text{ N/mm}^2$$

Loss due to shrinkage of concrete

$$= (200 \times 10^{-6}) \times E_s$$
$$= 200 \times 10^{-6} \times 2.1 \times 10^5$$
$$= 42 \text{ N/mm}^2$$

Therefore, all options (i), (ii) and (iii) are correct.

69. 1.50 (1.40 - 1.60)

$$\text{Initial stress in wire} = \frac{500 \times 10^3}{500} = 1000 \text{ N/mm}^2$$

When the beam is pretensioned, the total residual shrinkage strain = 3×10^{-4} units

$$\therefore \quad \text{Loss of stress} = (3 \times 10^{-4})(210 \times 10^3) = 63 \text{ N/mm}^2$$

$$\therefore \text{Percentage loss of stress} = \left(\frac{63}{1000} \times 100\right) = 6.3\%$$

When the beam is post tensioned, the total residual shrinkage strain

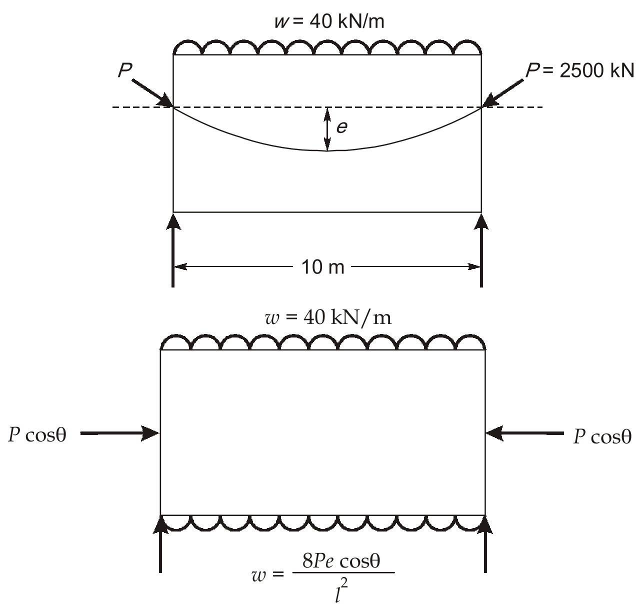
$$= \left[\frac{2 \times 10^{-4}}{\log_{10}(8+2)}\right] = 2 \times 10^{-4} \text{ units}$$

$$\therefore \quad \text{Loss of stress} = (2 \times 10^{-4}) \times (210 \times 10^3) = 42 \text{ N/mm}^2$$

$$\therefore \text{Percentage loss of stress} = \left(\frac{42}{1000} \times 100\right) = 4.2\%$$

$$\text{Required ratio} = \frac{6.3}{4.2} = 1.50$$

70. (c)



Load balancing concept

$$w = \frac{8Pe\cos\theta}{l^2}$$

$$\Rightarrow \quad 40 = \frac{8 \times 2500 \times e \times 1}{10^2} \qquad [\because \theta \text{ is very small thus } \cos\theta \simeq 1]$$

$$e = 0.2 \text{ m}$$
$$\Rightarrow \quad e = 200 \text{ mm}$$

71. (c)

72. **(a, b)**
Combined loading is not a complicated loading.

73. **(a, b, c, d)**
If the state of stress on two planes and angle between those planes is known, then with the help of Mohr's circle we can determine stresses on oblique section.

74. **(a, c, d)**
Percentage of steel is dependent on characteristic strength of concrete (f_{ck}) rather than its yield strength.

75. **(a, c)**
The design shear strength of concrete in *RC* beam depends upon grade of concrete i.e. compressive strength of concrete; percentage of longitudinal tension reinforcement; and axial compressive force.

■■■■