STRENGTH OF MATERIALS TEST 3

Number of Questions 25 **Time:60 min.**

Directions for questions 1 to 25: Select the correct alternative from the given choices.

1. A 30 m long steel tape with cross section 16 mm × 0.8 mm was used to measure distance between two points. The distance was measured as 180 m. If the force applied during measurement was 100 N more than the force applied at the time of calibration, actual length between the points is (E for steel = 200 kN/mm^2)

(A) 179.99 mm (B) 180.007 mm
(C) 179.02 mm (D) 180.07 mm

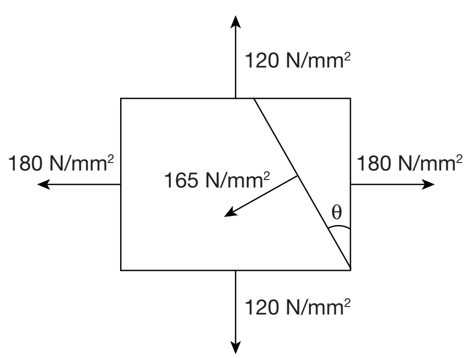
2. An alloy steel specimen of 30 mm diameter with a gauge length of 200 mm is load tested. It has an extension of 0.16 mm under a load of 85 kN. Load at elastic limit is 160 kN. Young's modulus of the specimen in GN/m^2 is

(A) 126.836 (B) 142.784
(C) 150.313 (D) 172.346

3. In a laboratory, tensile test is conducted and Young's modulus of the material was found to be 2.05×10^5 N/mm^2. On torsion test modulus of rigidity was found to be 0.78×10^5 N/mm^2. Then bulk modulus of the material is

(A) 183793 N/mm^2 (B) 172468 N/mm^2
(C) 168334 N/mm^2 (D) 166432 N/mm^2

4.



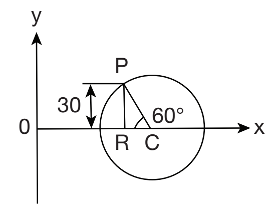
State of stresses at a point in a strained material is given above. Normal stress at an angle θ + 90 is

(A) 135 N/mm^2 (B) 150 N/mm^2
(C) 165 N/mm^2 (D) 180 N/mm^2

5. A simply supported beam of span 5 m and diameter 80 mm carries a concentrated central load of 8 kN. Maximum bending stress produced is

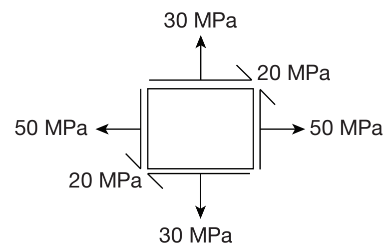
(A) 198.94 N/mm^2 (B) 202.82 N/mm^2
(C) 214.42 N/mm^2 (D) 218.36 N/mm^2

6. What is the maximum shear stress possible in the element when the shear stress in the oblique section is 30 MPa?



(A) 60 MPa (B) 30 MPa
(C) 34.64 MPa (D) 25.98 MPa

7.



What is the radius of the Mohr's circle for the element under the given state of stresses?

(A) 44.15 MPa (B) 10 MPa
(C) 20 MPa (D) 22.36 MPa

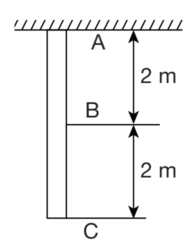
8. The ratio of section modulus of a cylindrical beam of diameter "*d*" to the section modulus of a hollow cylindrical beam of external diameter "*d*" and diameter ratio of 0.5 is

(A) 0.9375 (B) 1.067
(C) 0.067 (D) 1.143

9. A cylindrical rod of Young's modulus 100 MPa is fixed at one end. A load of 5 kN is acting at the free end. If the section modulus is 3.314×10^{-4}m^3 then what is the radius of curvature of the bended beam for a beam length of 2 m?

(A) 2.485 m (B) 248.5 mm
(C) 3.313 m (D) 331.3 mm

10. The deflection of point *B* due to the self weight of the rod of cross-sectional area 5 mm^2 and weight 60 N is (E = 200 GPa)

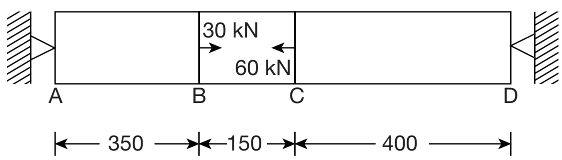


(A) 0.03 mm (B) 0.06 mm
(C) 0.09 mm (D) 0.008 mm

11. A bar of 1000 mm length and 40 mm diameter is centrally bored for 300 mm length at one end at a diameter of 20 mm. Young's modulus of the material is 2×10^5 N/mm^2. If the bar is loaded axially with a load of 30 kN the extension produced is

(A) 0.1136 mm (B) 0.1313 mm
(C) 0.1478 mm (D) 0.1542 mm

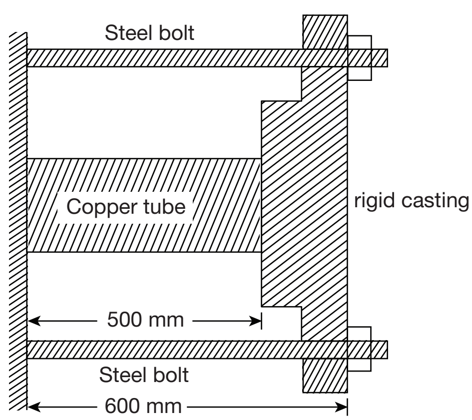
12.



A bar of 900 mm length is attached rigidly at *A* and *D* as shown in the figure. Forces 30 kN and 60 kN acts at points *B* and *C* as shown on the bar. If Young's modulus is 2×10^5 N/mm^2, reaction at the end *A* is

(A) 7.623 kN (B) 8.333 kN
(C) 9.426 kN (D) 9.934 kN

13.



A copper tube is tightened using 2 bolts between a rigid surface and a rigid casting as shown in the figure. Young's modulus for steel and copper are 2×10^5 N/mm^2 and 1.2×10^5 N/mm^2 respectively. Area of cross sections of steel bolt is 490 mm^2 and that of copper tube is 1100 mm^2. Pitch of nut is 3 mm. If nuts are given 60° turns to tighten the copper tube, tensile stress induced in the bolt is

(A) 74.492 MPa
(B) 78.364 MPa
(C) 82.468 Mpa
(D) 86.682 MPa

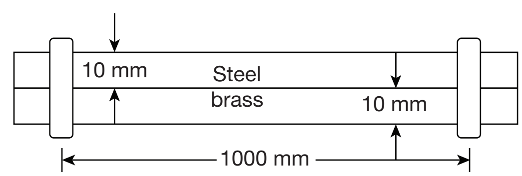
14. A bar of 20 mm diameter is tested in tension. When a load of 38 kN was applied extension of 0.12 mm was measured over a length of 200 mm and contraction in diameter was 0.004 mm. If Young's modulus is 2×10^5 N/mm^2 then the value of modulus of rigidity is

(A) 65000 N/mm^2 (B) 70000 N/mm^2
(C) 75000 N/mm^2 (D) 80000 N/mm^2

15. A steel bar length 600 mm and uniformly varying diameter 20 mm to 40 mm is held between two unyielding supports at room temperature of 30°C. Then it is heated to a temperature of 60°C. Maximum stress induced in the bar is
[Take Young's modulus = 2×10^5 MPa and coefficient of the thermal expansion
= 12×10^{-6}/°C]

(A) 102 MPa (B) 112 MPa
(C) 120 MPa (D) 144 MPa

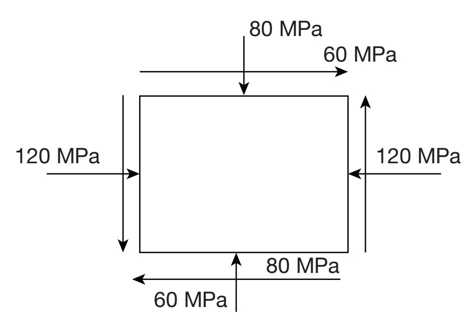
16. A compound bar is made of one steel strip and one brass strip of 60 mm wide × 10 mm thick rigidly connected on each end by using 16 mm diameter pins. When the bar is heated 70°C above room temperature the shear stress induced in the pins in N/mm^2 is
[given: distance between pins = 1000 mm



E for steel = 200 kN/mm^2
E for brass = 100 kN/mm^2
α for steel = 11.6×10^{-6}/°C
α for brass = 18.7×10^{-6}/°C]

(A) 98.875 (B) 106.865
(C) 124.248 (D) 137.826

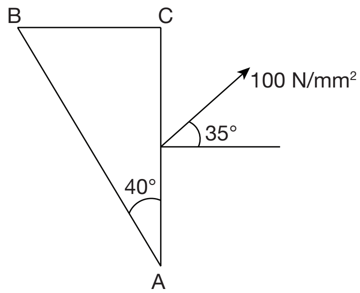
17.



State of stress in a two dimensionally stressed body is given in the figure above. Inclination of the plane of maximum shear stress nearest to the plane of normal stress of 120 MPa is

(A) 35.78° (B) 62.34°
(C) 71.56° (D) 80.78°

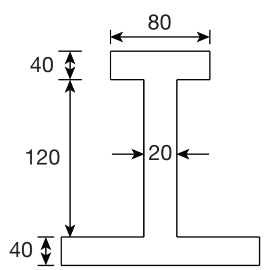
18. At a point in the vertical cross section of a beam, there is a resultant stress of 100 N/mm^2 which is inclined at 35° to the horizontal. On the horizontal plane through the point, there is only shearing stress. Value of normal stress on a plane AB inclined at 40° to vertical is



(A) 96.84 N-mm^2 (B) 104.56 N-mm^2
(C) 122.34 N-mm^2 (D) 134.75 N-mm^2

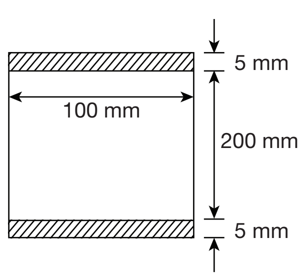
19. A circular pipe of external diameter 70 mm is used as a simply supported beam with span of 2.5 m. Permissible stress in the pipe is 150 N/mm^2. If the beam has to carry a concentrated load of 5 kN at the centre, minimum wall thickness required for the pipe is
(A) 7.5 mm (B) 8.5 mm
(C) 9.5 mm (D) 10.0 mm

20. A cast iron beam has an I cross section as shown in figure.



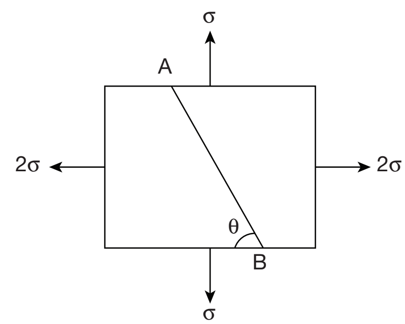
It is subjected to a uniformly distributed load at the top over a simply supported span. The neutral axis of section is at a distance 78.67 mm from the bottom fibre and moment of inertia about the neutral axis is 60138670 mm^4.If tensile stress is not to exceed 30 N/mm^2 and compressive stress is not to exceed 90 N/mm^2, moment carrying capacity of the beam is
(A) 16.74 kNm (B) 19.42 kNm
(C) 22.93 kNm (D) 24.86 kNm

21. A 5 m long simply supported timber beam of rectangular section 100 mm width and 200 mm deep is strengthened by 5 mm thick steel plates of width 100 mm at top and bottom over entire length. Moment carrying capacity of the beam is



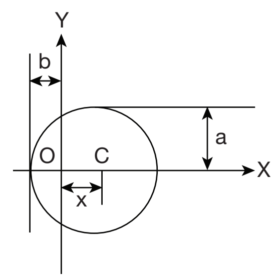
[Permissible tensile stress for steel = 156 N/mm^2
Permissible tensile stress for timber = 15 N/mm^2
Young's modulus for steel = 2×10^5 N/mm^2
Young's modulus for timber = 0.12×10^5 N/mm^2]
(A) 16.04 kN-m (B) 18.14 kN-m
(C) 19.62 kN-m (D) 21.51 kN-m

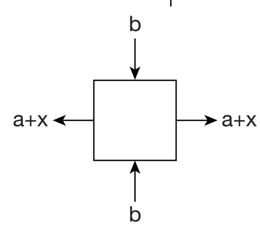
22. A rectangular body of unit thickness is subjected to tensile stresses as shown. What is the angle of obliquity of an oblique section *AB* (θ = 45°)?

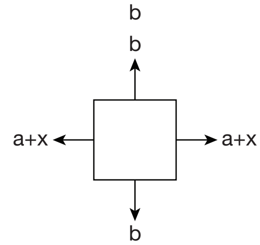


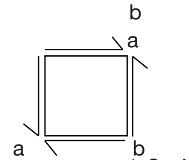
(A) 45° (B) 18.435°
(C) 36.87° (D) 22.5°

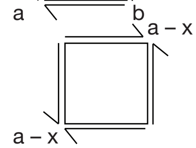
23. The Mohr's circle for a element is given with *C* as the centre of the circle. The state of stress in the element can be shown as:



(A)


(B)


(C)


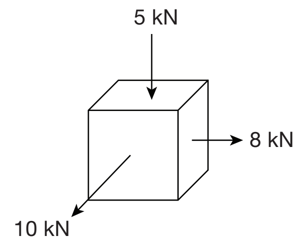
(D)


24. Two beams of same material having cross sections of square (side length a) and circle (diameter d) are simply supported when a central point load is acted upon them. What is the ratio of radius of gyration of the square beam to the circular beam if the lengths of the beams are equal?

(A) $1.69\left(\frac{d}{a}\right)^4$ (B) $1.69\left(\frac{a}{d}\right)^4$

(C) $0.589\left(\frac{d}{a}\right)^4$ (D) $0.589\left(\frac{a}{d}\right)^4$

25. A aluminium cube of side 100 mm is subjected to forces as shown. What is the change in volume if the Young's modulus is 70 GPa and Poisson's ratio is 0.25



(A) 13.732 mm^3 (B) 10.694 mm^3
(C) 9.272 mm^3 (D) None of these

Answer Keys

1. B	**2.** C	**3.** A	**4.** A	**5.** A	**6.** C	**7.** D	**8.** B	**9.** B	**10.** C
11. B	**12.** B	**13.** A	**14.** C	**15.** D	**16.** A	**17.** D	**18.** B	**19.** A	**20.** C
21. D	**22.** B	**23.** A	**24.** B	**25.** C					

Hints and Explanations

1. A = 16 × 0.8 = 12.8 mm^2
P = 100 N
L = 30 m = 30,000 mm
E = 200 kN/mm^2 = 200 × 10^3 N/mm^2

$$\Delta = \frac{PL}{AE} = \frac{100 \times 30,000}{12.8 \times 200 \times 10^3} = 1.172 \text{ mm}$$

If the measured length is 30 m, actual length
= 30 + (1.172 × 10^{-3}) mm
= 30.001172 m

∴ Actual distance between the points

$$= 180 \times \frac{30.001172}{30} = 180.007 \text{ mm}$$ Choice (B)

2. $$E = \frac{PL}{A\Delta} = \frac{85 \times 10^3 \times 200}{\frac{\pi}{4}(30)^2 \times 0.16} \text{ N/mm}^2$$

= 150313 N/mm^2
= 150.313 GN/m^2. Choice (C)

3. E = 2.05 × 10^5 N/mm^2
G = 0.78 × 10^5 N/mm^2

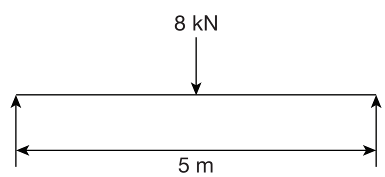
$$E = \frac{9GK}{3K + G}$$

i.e. $$2.05 \times 10^5 = \frac{9 \times 0.78 \times 10^5 K}{3K + 0.78 \times 10^5}$$

6.15 K + 159900 = 7.02 K
159900 = 0.87 K
K = 183793 N/mm^2 Choice (A)

4. Sum of normal stresses at any mutually perpendicular planes is = $\sigma_x + \sigma_y$
Let σ_n be the normal stress at a plane at angle θ + 90°
∴ $165 + \sigma_n = \sigma_x + \sigma_y$
i.e. $165 + \sigma_n = 120 + 180$
⇒ $\sigma_n = 135$ N/mm^2. Choice (A)

5.



Maximum bending moment

$$M = \frac{WL}{4} = \frac{8 \times 5}{4} = 10 \text{ kN m} = 10 \times 10^6 \text{ N-mm}$$

Maximum bending stress

$$f_{max} = \frac{M}{z} = \frac{M \times 32}{\pi(80)^3} = \frac{10 \times 10^6 \times 32}{\pi \times (80)^3}$$

= 198.94 N/mm^2 Choice (A)

6. The maximum shear stress is given by the radius of the Mohr's circle i.e. PC
From triangle PCR

$$\text{Sin}(60) = \frac{PR}{PC}$$

⇒ $$PC = \frac{PR}{\text{Sin}(60)} \quad \frac{30}{\text{Sin}\,60}$$

∴ PC = 34.64 MPa Choice (C)

7. The radius of the Mohr's circle is the maximum shear stress induced in the element i.e.,

$$\tau_{max} = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^{\ 2}}$$

$\therefore \quad \tau_{max} = \sqrt{\left(\frac{50-30}{2}\right)^2 + 20^2}$

$\tau_{max} = 22.36$ MPa Choice (D)

8. $Z_1 = \frac{\pi}{32} d^3$

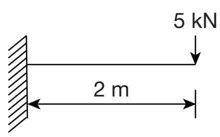
$Z_2 = \frac{\pi}{32} d^3 \left[1 - \left(\frac{d_i}{d}\right)^4\right]$ here, $\frac{d_i}{d} = 0.5$

$Z_2 = \frac{\pi}{32} d^3 [1-(0.5)^4] = 0.9375 \frac{\pi}{32} d^2$

$\therefore \quad \frac{Z_1}{Z_2} = \frac{\frac{\pi}{32} d^3}{0.9375 . \frac{\pi}{32} d^3} = \frac{1}{0.9375} = 1.067$

Choice (B)

9.



$Z = \frac{\pi}{32} d^3 = 3.314 \times 10^{-4} m^3 \Rightarrow d = 150$ mm

Using bending equation

$\frac{M}{I} = \frac{E}{R}$

$M = (5 \times 10^3) \times 2 = 10 \times 10^3$ Nm

$I = \frac{\pi}{64} \times d^4 = \frac{\pi}{64} \times (0.15)^4 = 2.485 \times 10^{-5} m^4$

$\therefore \quad R = \frac{I}{M} . E = \frac{2.485 \times 10^{-5}}{10 \times 10^3} \times 100 \times 10^6$

$\therefore \quad R = 248.5$ mm Choice (B)

10. Deflection at point B = Due to self weight of AB + due to weight of BC

$\delta L_{AB} = \frac{WL}{2AE}$

$W = \frac{60}{2} = 30$ N, $L = 2$ m, $A = 5$ mm^2

$E = 200 \times 10^3$ N/mm^2

$\therefore \quad \delta L_{AB} = \frac{30 \times 2 \times 10^3}{2 \times 5 \times 200 \times 10^3} = 0.03$ mm

$\delta L_{BC} = \frac{WL}{AE}$

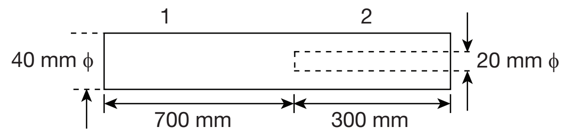
$W = 30$ N, $L = 2 \times 10^3$ mm , $A = 5$ mm^2

$E = 200 \times 10^3$ N/mm^2.

$\delta L_{BC} = \frac{30 \times 2 \times 10^3}{5 \times 200 \times 10^3} = 0.06$ mm

$\therefore$ deflection at point B = $\delta L_{AB} + \delta L_{BC}$
= 0.03 + 0.06 = 0.09 mm Choice (C)

11.



$A_1 = \frac{\pi}{4} 40^2 = 1256.64$ mm^2

$A_2 = \frac{\pi}{4} (40^2 - 20^2) = 942.48$ mm^2

$E_1 = 2 \times 10^5$ N/mm^2

$P = 30$ kN = 30,000 N

Extension $\Delta_1 = \frac{PL_1}{A_1 E}$;

$\Delta_2 = \frac{PL_2}{A_2 E}$

Total extension

$\Delta = \Delta_1 + \Delta_2$

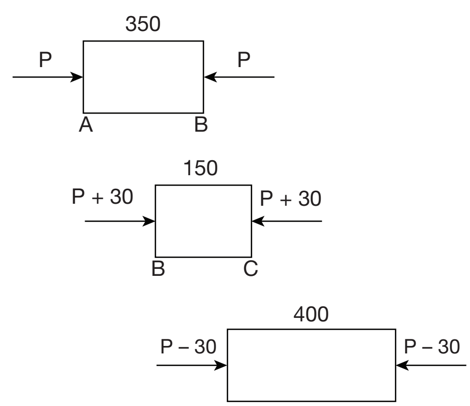
$= \frac{P}{E}\left[\frac{L_1}{A_1} + \frac{L_2}{A_2}\right]$

$= \frac{30,000}{2 \times 10^5}\left[\frac{700}{1256.64} + \frac{300}{942.48}\right]$

= 0.1313 mm. Choice (B)

12. Let P be the reaction at end A

Forces acting on each portion of bar is as shown



Total extension of the bar = 0

i.e. $\frac{P \times 350}{AE} + \frac{(P+30)150}{AE} + \frac{(P-30) \times 400}{AE} = 0$

or 350 P + 150 P + 400 P + (30 × 150) – (30 × 400) = 0

900 P = 7500

P = 8.333 kN. Choice (B)

13. Axial distance moved by nut

$\Delta = \text{pitch} \times \frac{60}{360} = \frac{3 \times 60}{3600} = 0.5$ mm

$\Delta = \Delta s + \Delta c$ → (1)

where Δs = extension steel bolt and

Δc = contraction of copper tube

Area of cross section

$A_s = 490\ mm^2$

$A_c = 1100\ mm^2$

From static equilibrium conditions

$2P_s = P_c$ → (2)

From (1)

$$\frac{P_s L}{A_S E_S} + \frac{P_C L}{A_C E_C} = 0.5$$

$$i.e.\ \frac{P_S \times 600}{490 \times 2 \times 10^5} + \frac{2P_S \times 500}{1100 \times 1.2 \times 10^5} = 0.5$$

$$\frac{P_S \times 600}{490 \times 2} + \frac{2P_S \times 500}{1100 \times 1.2} = 0.5 \times 10^5$$

⇒ $P_s = 36501$ N

Tensile stress is steel bolts

$$= \frac{P_S}{Area} = \frac{36501}{490}$$

$= 74.492\ N/mm^2$

$= 74.492$ MPa. Choice (A)

14. Linear strain $= \frac{\Delta}{L} = \frac{0.12}{20} = 0.0006$

Lateral strain $= \frac{\Delta d}{d} = \frac{0.004}{20} = 0.0002$

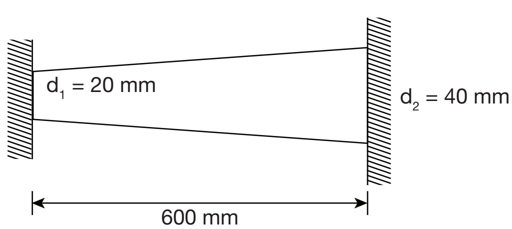
Poissons ratio $\mu = \frac{\text{Linear strain}}{\text{Lateral strain}} = \frac{0.0002}{0.0006} = 0.333$

$E = 2 \times 10^5\ N/mm^2$

Modulus of rigidity $G = \frac{E}{2(1+\mu)} = \frac{2 \times 10^5}{2(1.333)}$

$G = 75{,}000\ N/mm^2$. Choice (C)

15.



Let P be the force developed at the supports

Free expansion is blocked,

$$\alpha\, t\, L = \frac{PL}{\frac{\pi}{4} d_1 d_2 E}$$

$$\text{i.e. } 12 \times 10^{-6} \times (60 - 30) = \frac{P}{\frac{\pi}{4} \times 20 \times 40 \times 2 \times 10^5}$$

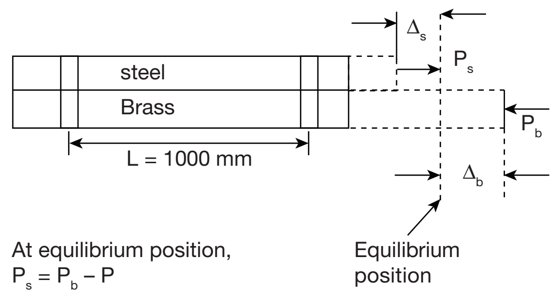
⇒ $P = 45{,}238.93$ N

Maximum stress = stress at smaller diameter end

$$= \frac{45{,}238.93}{\frac{\pi}{4} \times 20^2} N/mm^2 = 144\ N/mm^2$$

= 144 MPa. Choice (D)

16.



At equilibrium position,

$P_s = P_b - P$

$$\Delta_s = \frac{PL}{AE_s},\ \Delta_b = \frac{PL}{AE_b}$$

Free expansion of steel $= \alpha_s\, t\, L$

Pre expansion of brass $= \alpha_b\, t\, L$

$$(\alpha_b\, t\, L - \alpha_s\, t\, L) = \frac{PL}{AE_s} + \frac{PL}{AE_b}$$

$$t[a_s - a_s] = \frac{P}{A}\left[\frac{1}{E_S} + \frac{1}{E_b}\right]$$

$$70 \times 10^{-6}[18.7 - 11.6] = \frac{P}{60 \times 10} \times \frac{1}{10^5}\left[\frac{1}{2} + \frac{1}{1}\right]$$

$$70 \times 7.1 = \frac{P}{60} \times \frac{3}{2}$$

⇒ $P = 19880$ N

Shear stress in the pin

$$\tau = \frac{P}{A}$$

where A = area of cross section of the pin

$$\text{i.e. } \tau = \frac{19880}{\frac{\pi}{4} \times (16)^2} = 98.875\ N/mm^2.$$

Choice (A)

17. Let θ be the angle made by principal plane with the plane of σ_x

i.e. 120 MPa

$$\tan 2\theta = \frac{2\tau}{\sigma_x - \sigma_y} = \frac{2 \times 60}{-120 + 80}$$

$$= -\frac{120}{40} = -3$$

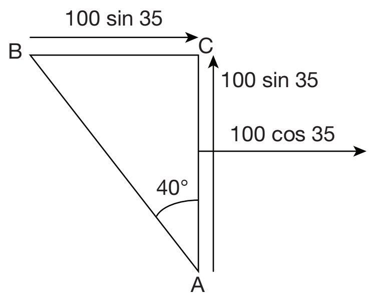
$2\theta = -71.56° ⇒ 71.56°$ clockwise

$\theta = 35.78°$

Plane of maximum shear stresses are at 45° to principal planes
i.e. at 35.78 + 45 = 80.78°.

Choice (D)

18.



Resolving the resultant stress to horizontal and vertical components, the state of stress is as shown in the figure

σ_x = 100 cos35 = 81.92 N/mm^2

τ = 100 sin35 = 57.36 N/mm^2

$\sigma_y = 0$

Normal stress on AB

$$\sigma_n = \frac{\sigma_x+\sigma_y}{2}+\frac{\sigma_x-\sigma_y}{2}\cos 2\theta+\tau\sin 2\theta$$

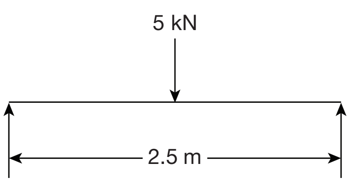
$$= \frac{81.92}{2}+\frac{81.92}{2}\cos 80+57.36\sin 80$$

= 48.073 + 56.489

= 104.56 N/mm^2.

Choice (B)

19.



Maximum bending moment

$$M = \frac{P\ell}{4} = \frac{5000\times 2.5}{4} = 3125 \text{ Nm}$$

$$z = \frac{I}{y_{\max}} = \frac{\pi}{64}(70^4-d^4)\times\frac{1}{35}$$

where d = inside diameter

σ = 150 N/mm^2

Equating maximum bending moment to moment carrying capacity

M = σ z

i.e. $3125 \times 10^3 = 150 \times \frac{\pi}{64\times 35}(70^4-d^4)$

$70^4 - d^4$ = 14854,461

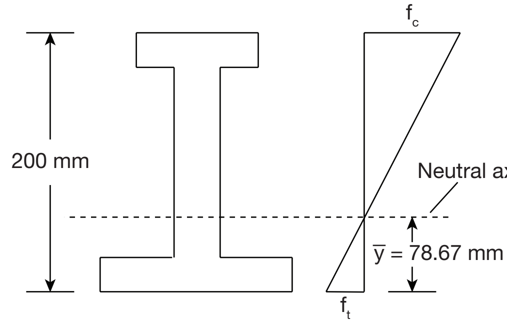
⇒ d = 55 mm

Wall thickness of pipe $= \frac{D-d}{2}$

$= \frac{70-55}{2}$ = 7.5 mm.

Choice (A)

20. As the beam is subjected to a uniformly distributed load at the top, the beam will be under tension at the bottom and under compression at the top.



Moment carrying capacity considering tensile strength

M = $F_t \times z$

$$= F_t\times\frac{I}{y_t} = 30\times\frac{60138670}{78.67} = 22.93 \text{ kN-m}$$

Moment carrying capacity considering compressive stress

$$M = f_c\frac{I}{y_c} = 90\times\frac{60138670}{(200-78.67)}$$

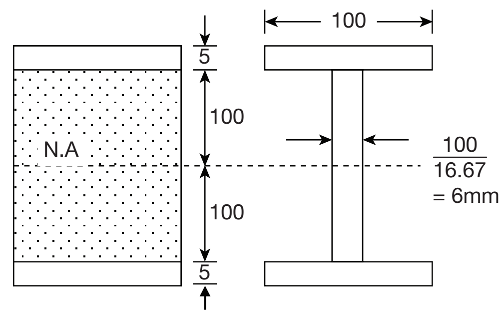
= 44609,580 N mm = 44.61 kN-m

The maximum bending moment applied cannot exceed 22.93 kN m or moment carrying capacity is 22.93 kN-m.

Choice (C)

21. Modular ratio $m = \frac{E_s}{E_t}$

$$= \frac{2\times10^5}{0.12\times10^5} = 16.67$$



Permissible stress in steel = 156 N/mm^2

Corresponding stress in timber at 100 mm from

NA = $156 \times \frac{100}{105}\times\frac{1}{m}$ = 8.91 N/mm^2

Permissible stress in timber = 15 N/mm^2

Corresponding stress in steel at 105 mm from

$NA = 15\times\frac{105}{100}\times m$

= 262.55 N/mm^2

∴ Moment carrying capacity is based on permissible stress in steel

i.e. σ_s = 156 N/mm^2

Equivalent width of timber = $\frac{100}{16.67}$ = 6 mm

Moment of inertia of equivalent section in steel

$$I = \frac{10 \times 210^3}{12} - \frac{(100-6)\times 200^3}{12}$$

= 14.5 × 10^6 mm^4

Moment carrying capacity

$$M = \sigma_s \frac{I}{y_{max}}$$

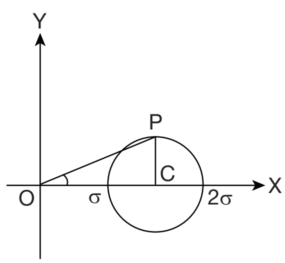
$$= 156 \times \frac{14.5 \times 10^6}{105}$$

= 21.543 × 10^6 N-mm

= 21.543 kN-m. Choice (D)

22. Angle of obliquity is the angle made by the resultant stress with the normal stress.

∴ By drawing the Mohr's circle, we get:



The section *AB* making, an angle of 45° is represented by *CP* on the Mohr's circle.

CP is the shear stress on *AB*

OC is the normal stress on *AB* and

OP is the resultant stress.

∴ The angle δ is the angle of obliquity which can be calculated as

$$\tan\delta = \frac{CP}{OC} = \frac{\sigma/2}{\sigma + \sigma/2} = \frac{1}{3}$$

∴ $\delta = \tan^{-1}\left(\frac{1}{3}\right) = 18.435°$ Choice (B)

23. From the Mohr's circle

$\sigma_1 = a + x$ (tensile)

$\sigma_2 = b$ (compressive)

∴ Option A is the correct answer Choice (A)

24. By bending equation

$$\frac{M}{I} = \frac{E}{R} \Rightarrow R = \frac{I}{M}.E$$

$$\frac{R_S}{R_C} = \left(\frac{1}{M}.E\right)_S \times \left(\frac{M}{1.E}\right)_C$$

∵ They are made of same material

E is same for both and the bending moment acting on the beams is

$M = \frac{W.L}{4}$, W = load (central point load)

Bending moment is also equal for both the beams

∴ $\frac{R_S}{R_C} = \frac{I_S}{I_C}$

∴ $I_s = \frac{a^4}{12}$

$I_c = \frac{\pi}{64} d^4$

∴ $\frac{R_s}{R_c} = \frac{a^4}{12} \times \frac{64}{\pi d^4} = 1.69\left(\frac{a}{d}\right)^4$ Choice (B)

25. Volume of the cube = 100 × 100 × 100 = 10^6 mm^3

Stress in *X* direction = $\frac{8 \times 10^3}{200 \times 100}$ = 0.8 N/mm^2

Stress in *Y* direction = $\frac{10 \times 10^3}{100 \times 100}$ = 1 N/mm^2

Stress in *Z* direction = $\frac{-5 \times 10^3}{100 \times 100}$ = –0.5 N/mm^2

∴ Strains are given as

$$\varepsilon_x = \frac{\sigma_x}{E} - \frac{\sigma_y}{mE} - \frac{\sigma_z}{mE} = \frac{1}{E}[0.8 - (0.25 \times 1) - (0.25 \times 0.5)]$$

∴ $\varepsilon_x = \frac{1}{70 \times 10^3} \times 0.675$ = 9.6428 × 10^{-6}

$$\varepsilon_y = \frac{\sigma_y}{E} - \frac{\sigma_z}{mE} - \frac{\sigma_x}{mE} = \frac{1}{E}[1 - (0.25 \times -0.25) - (0.25 \times 0.8)]$$

∴ ε_y = 13.214 × 10^{-6}

$$\varepsilon_z = \frac{\sigma_z}{E} - \frac{\sigma_x}{mE} - \frac{\sigma_y}{mE} = \frac{1}{E}[-0.5 - (0.25 \times 0.8) - (0.25 \times 1)]$$

∴ ε_z = –13.571 × 10^{-6}

∴ $\frac{\delta V}{V} = \varepsilon_x + \varepsilon_y + \varepsilon_z$

∴ $\frac{\delta V}{10^6} = [9.6428 + 13.214 + (-13.571)] \times 10^{-6}$

δV = 9.272 mm^3

Choice (C)