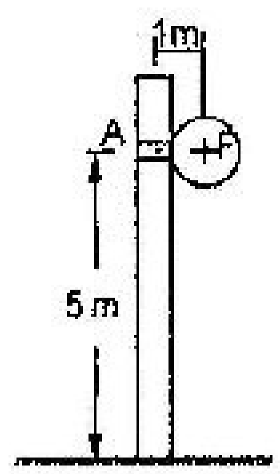
**21.** Consider the signboard mounting shown in the figure. The wind load acting perpendicular to the plane of the figure is F = 100 N. We wish to limit the deflection, due to bending, at point A of the hollow cylindrical pole of outer diameter 150 mm to 5 mm. Find the wall thickness for the pole. Assume $E = 2.0 \times 10^{11}$ N/m$^2$.




**Solution :** Given : F = 100 N; $d_0$ = 150 mm

= 0.15 m; $y$ = 5 mm; $E = 2.0 \times 10^{11}$ N/m$^2$

**Thickness of pole, *t*:**

The system of signboard mounting can be considered as a cantilever loaded at A, *i.e.*, W = 100 N and also having anticlockwise moment of M = 100 × 1 = 100 Nm at the free end.

Deflection of cantilever having concentrated load at the free end,

$$y = \frac{W\,l^3}{3\,EI} + \frac{M\,l^2}{2\,EI}$$

or $$5 \times 10^{-3} = \frac{100 \times 5^3}{3 \times 2.0 \times 10^{11} \times 1} + \frac{100 \times 5^2}{2 \times 2.0 \times 10^{11} \times 1}$$

or $$I = \frac{1}{5 \times 10^{-3}}\left[\frac{10 \times 5^3}{3 \times 2.0 \times 10^{11}} + \frac{100 \times 5^2}{2 \times 2.0 \times 10^{11}}\right]$$

or $$= \frac{200}{10^{11}}(2083.33 + 625) = 5.417 \times 10^{-6}$$

But $$= \frac{\pi}{64}\left(0.15^4 - d_i^4\right)$$

$\therefore$ $$5.417 \times 10^{-6} = \frac{\pi}{64}\left(0.15^4 - d_1^4\right)$$

or $$0.15^4 - d_i^4 = \frac{5.417 \times 10^{-5} \times 64}{\pi}$$

$$= 110.35 \times 10^{-6}$$

or, $$d_i^4 = 0.15^4 - 110.35 \times 10^{-6} = 0.0003959$$

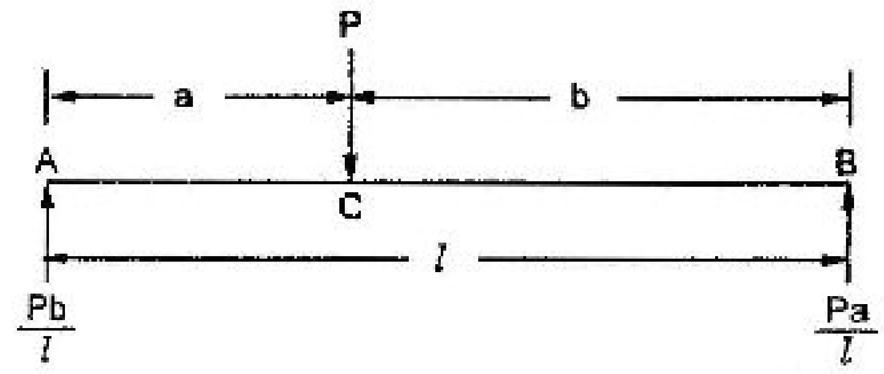
or, $$d_i = 0.141 \text{ m or } 141 \text{ mm}$$

$\therefore$ $$t = \frac{d_0 - d_1}{2}$$

$$= \frac{150 - 141}{2} = 4.5 \text{ mm}$$

**22.** A simply supported beam is subjected to a single force P at a distance '*b*' from one of the supports. Obtain the expression for the deflection under the load using Castigliano's theorem. How do you calculate deflection at the mid-point of the beam ?

**Solution.** Let the load P acts at a distance *b* from the support B, and *l* be the total length of the beam.




Reaction at A, $R_A = \dfrac{Pb}{l}$

and, Reaction at B, $R_B = \dfrac{Pa}{l}$

Strain energy stored by beam AB,

U = strain energy stored by AC ($U_{AC}$) + strain energy stored by BC ($U_{BC}$)

$$= \int_0^a \left(\frac{Pb}{l}.x\right)^2 \frac{dx}{2\,EI} + \int_0^b \left(\frac{Pa}{l}.x\right)^2 \frac{dx}{2\,EI}$$

$$= \frac{P^2 b^2 a^3}{6\,EI\,l^2} + \frac{P^2 a^2 b^3}{6\,EI\,l^2} = \frac{P^2 a^2 b^2}{6\,EI\,l^2}(a + b)$$

$$= \frac{P^2 b^2 a^2}{6\,EI\,l} = \frac{P^2 (l - b)^2 b^2}{6\,EI\,l} \quad [\because (a + b) = l]$$

Deflection under the load P, $\delta = (= y) = \dfrac{\partial U}{\partial P}$

$$= \frac{2P(l - b)^2 b^2}{6\,EI\,l} = \frac{P(l - b)^2 b^2}{3\,EI\,l}$$

Deflection at the mid-span of the beam can be found by Macaulay's method.

By Macaulay's method, deflection at any section is given by,

$$EIy = \frac{Pbx^3}{6l} - \frac{Pb}{6l}(l^2 - b^2)x - \frac{P(x - a)^3}{6}$$

where $y$ is deflection at any distance x from the support.

At, $x = \dfrac{1}{2}$, *i.e.*, at mid-span,

$$EIy = \frac{Pb \times \left(\frac{l}{2}\right)^3}{6l} - \frac{Pb}{6l}(l^2 - b^2) \times \frac{l}{2} - \frac{P\left(\frac{l}{2} - a\right)^3}{6}$$

or $$EIy = \frac{Pbl^2}{48} - \frac{Pb(l^2 - b^2)}{12} - \frac{P\left(l - 2a\right)^3}{48}$$

$$y = \frac{P}{48\,EI}\left[bl^2 - 4b(l^2 - b^2) - (l - 2a)^3\right]$$

**23.** A tube 40 mm outside diameter, 5 mm thick and 1.5 m long, simply supported at 125 mm from each end carries a concentrated load of 1 kN at each extreme end.

(i) Neglecting the weight of the tube, sketch the shearing force and bending moment diagrams;

(ii) Calculate the radius of curvature and deflection at mid-span. Take the modulus of elasticity of the material as 208 GN/m².

**Solution.** Given,

$$d_0 = 40 \text{ mm} = 0.04 \text{ m};$$
$$d_i = d_0 - 2l = 40 - 2 \times 5 = 30 \text{ mm} = 0.03 \text{ m};$$
$$W = 1 \text{ kN};$$
$$E = 208 \text{ GN/m}^2 = 208 \times 10^9 \text{ N/m}^2;$$
$$l = 1.5 \text{ m};$$
$$a = 125 \text{ mm} = 0.125\text{m}$$

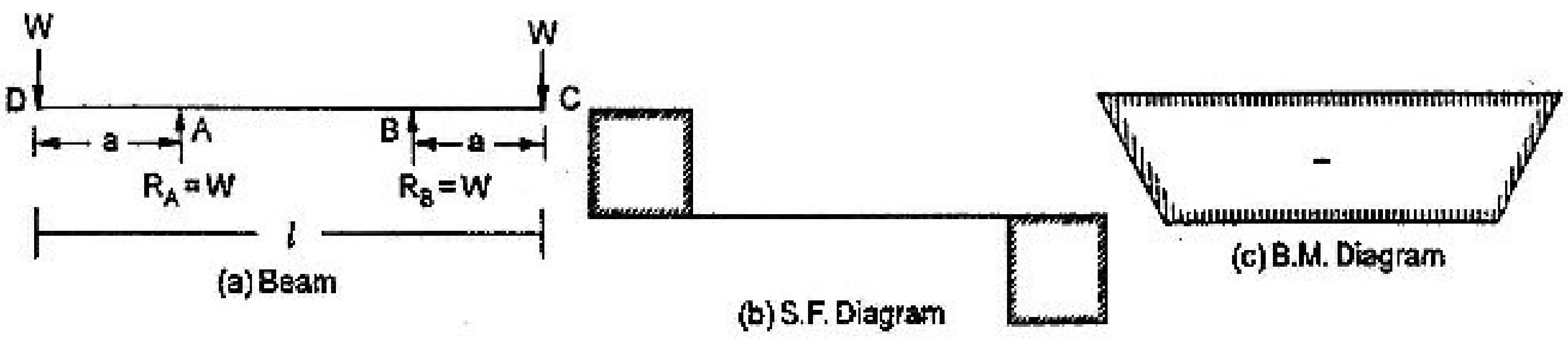
(i) S.F. and B.M. diagrams are shown respectively in the figure.

(ii) As per bending equation : $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$

or $$R = \frac{EI}{M} \quad ...(i)$$

Here, $$M = W \times a = 1 \times 10^3 \times 0.125 = 125 \text{ Nm}$$

$$I = \frac{\pi}{64}(d_0^4 - d_i^4)$$
$$= \frac{\pi}{64}\left[(0.04)^4 - (0.03)^4\right] = 8.59 \times 10^{-8} \text{ m}^4$$



(a) Beam (b) S.F. Diagram (c) B.M. Diagram

Substituting the values in equation (i), we get,

$$R = \frac{208 \times 10^9 \times 8.59 \times 10^{-8}}{125} = 142.9 \text{ m}$$

**Definition at mid-span:**

$$EI\frac{d^2y}{dx^2} = M_x = -Wx + W(x - a)$$
$$= -Wx + Wx - Wa = -Wa$$

Integrating, we get, $EI\frac{dy}{dx} = -Wax + C_1$

When, $x = \frac{l}{2}, \frac{dy}{dx} = 0$

$$\therefore \quad 0 = -Wa\frac{l}{2} + C_1$$

or, $$C_1 = \frac{W\,al}{2}$$

$$\therefore \quad EI\frac{dy}{dx} = -Wax + \frac{W\,al}{2}$$

Integrating again, we get,

$$EI\,y = \frac{W\,ax^2}{2} + \frac{W\,al}{2}x + C_2$$

When, $x = a, y = 0$

$$\therefore \quad 0 = \frac{W\,a^3}{2} + \frac{W\,a^2l}{2} + C_2$$

or, $$C_2 = \frac{W\,a^3}{2} - \frac{W\,a^2l}{2}$$

$$\therefore \quad EI\,y = -\frac{W\,ax^2}{2} + \frac{W\,alx}{2} + \left[\frac{W\,a^3}{2} - \frac{W\,a^2l}{2}\right]$$

or, $$y = \frac{Wa}{EI}\left[-\frac{x^2}{2} + \frac{lx}{2} + \frac{a^2}{2} - \frac{al}{2}\right]$$

At mid-span, *i.e.*, at $x = \frac{l}{2}$,

$$y = \frac{Wa}{EI}\left[-\frac{\left(\frac{l}{2}\right)^2}{2} + \frac{l \times \left(\frac{l}{2}\right)}{2} + \frac{a^2}{2} - \frac{al}{2}\right]$$

$$= \frac{Wa}{EI}\left[-\frac{l^2}{8}+\frac{l^2}{4}+\frac{a^2}{a}-\frac{al}{2}\right]$$

$$= \frac{Wa}{EI}\left[\frac{l^2}{8}+\frac{a^2}{2}-\frac{al}{2}\right]$$

$$= \frac{1\times 1000\times 0.125}{208\times 10^9\times 8.59\times 10^{-8}}\left[\frac{1.5^2}{8}+\frac{0.125^2}{2}-\frac{0.125\times 1.5}{2}\right]$$

$$= 0.006996\,(0.28125 + 0.007812 - 0.09375)$$

$$= 0.001366 \text{ m} = 1.366 \text{ mm}$$

Hence, deflection at mid-span = 1.366 mm upwards

**24.** A hollow shaft of diameter ratio $\frac{3}{8}$ is required to transmit 600 kW at 110 r.p.m., the maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MN/m² and the twist in a length of 3 m not to exceed 1.4 degrees. Calculate the maximum external diameter satisfying these conditions.

Take : C = 84 GN/m².

**Solution.** Let, $\frac{3}{8}$ = internal diameter of the hollow shaft, and

D = external diameter of the hollow shaft.

$$d = \frac{3}{8}\text{D} = 0.375\text{ D (given)}$$

P = 600 kW; N = 110 r.p.m., $\tau$ = 63 MN/m²;

$\theta = 1.4°$; $l = 3$; $T_{max} = 1.2\ T_{mean}$

We know $$P = \frac{2\pi NT}{60\times 1000}$$

or $$600 = \frac{2\pi\times 100\times T}{60\times 1000}$$

$$T = \frac{600\times 60\times 1000}{2\pi\times 110} = 52087 \text{ Nm}$$

$$T = T_{mean} = 52087 \text{ Nm}$$

$$\therefore\quad T_{max} = 1.2\ T_{mean} = 1.2\times 52087 = 62504 \text{ Nm}$$

**1st Case : When shear stress is not to exceed 63 MN/m²**

From torsion equation, $\frac{T}{I_p} = \frac{\tau}{R} = \frac{2\tau}{D}$,

we have $$T = I_p\,\frac{2\tau}{D} = \frac{\pi}{32}(D^4 - d^4)\frac{2\tau}{D}$$

or, $$T = \tau\,\frac{\pi}{16}\left(\frac{D^4 - d^4}{D}\right)$$

or, $$62504 = 63\times 10^6\times\frac{\pi}{16}\left(\frac{D^4-(0.375D)^4}{D}\right)$$

or, $$62504 = 63\times 10^6\times\frac{\pi}{16}\times 0.9802\ D^3$$

$$\therefore\quad D^3 = \frac{62504\times 16}{63\times 10^6\times\pi\times 0.9802} = 5.155\times 10^{-3}\text{ m}^3$$

or D = 0.1727 m or 172.7 mm ...(*i*)

**2nd Case : When angle of twist is not to exceed 1.4°, D :**

We know that, $$\frac{T}{I_p} = \frac{C\theta}{l}$$

or, $$T = I_p\,.\,\frac{C\theta}{l}$$

$$= \frac{\pi}{32}(D^4 - d^4)\times\frac{84\times 10^9\times 1.4\times\pi}{3\times 180}$$

$$62504 = \frac{\pi}{32}[D^4 - (0.375\ D)^4]\times\frac{84\times 10^9\times 1.4\times\pi}{3\times 180}$$

or $$62504 = 6.584\times 10^7\ D^4$$

$$\therefore\quad D = 0.1755 \text{ m or } 175.5 \text{ mm}$$

From above two values (*i*) and (*ii*), we find that external diameter of the shaft should be 175.5 mm (greater of the two values)

# EXERCISE - I

**1.** Young's modulus of a wire is defined as the stress which will increase the length of wire compared to its original length by

(a) half (b) same amount
(c) double (d) one-fourth

**2.** A material obey's Hooke's law up to

(a) Plastic limit (b) Elastic limit
(c) Yield point (d) Limit of proportionality

**3.** After reaching the yielding stage while testing a mild steel specimen, strain

(a) becomes constant
(b) starts decreasing
(c) increases without any increase in load
(d) none of these

**4.** True stress-strain curve for materials is plotted between

(a) load/original cross-sectional area and change in length/original length
(b) load/instantaneous cross-sectional area and $\log_e \left(\frac{\text{original area}}{\text{instantaneous area}}\right)$
(c) load/instantaneous cross-sectional area and change in length/original length
(d) load/instantaneous area and instantaneous area / original area

**5.** A cube subjected to three mutually perpendicular stress of equal intensity $p$ expenses a volumetric strain

(a) $\frac{3p}{E}\left(\frac{2}{m}-1\right)$ (b) $\frac{3p}{E}(2-m)$
(c) $\frac{3p}{E}\left(1-\frac{2}{m}\right)$ (d) $\frac{E}{3p}\left(\frac{2}{m}-1\right)$

**6.** Impact strength of a material is an index of its

(a) toughnesss
(b) tensile strength
(c) capability of being cold worked
(d) hardness

**7.** Volumetric strain for a rectangular specimen of length $l$, breadth b and thickness t subjected to a pull of P is given by

(a) $e(1-2\text{ m})$ (b) $e\left(l-\frac{2}{m}\right)$
(c) $e(\text{m}-2)$ (d) $e\left(\frac{2}{m}-l\right)$

**8.** A hollow shaft of same cross-section area as solid shaft transmits

(a) same torque (b) less torque
(c) more torque (d) unpredictable

**9.** The intensity of stress which causes unit strain is called

(a) unit stress (b) modulus of rigidity
(c) bulk modulus (d) modulus of elasticity

**10.** A composite bar made up of steel and copper bars of equal lengths are heated through 100°C. The stresses developed shall be

(a) tensile in both the materials
(b) tensile in steel and compressive in copper
(c) compressive in steel and tensile in copper
(d) compressive in both the materials

**11.** Within elastic limit, stress is

(a) inversely proportional to strain
(b) directly proportinal to strain
(c) square root of strain
(d) equal to strain

**12.** Modulus of rigidity is defined as the ratio of

(a) longitudinal stress and longitudinal strain
(b) volumetric stress and volumetric strain
(c) lateral stress and lateral strain
(d) shear stress and shear strain

**13.** The shape of cantilever for uniformly distributed load will be

(a) straight line (b) parabolic
(c) parabolic (d) elliptical

**14.** The ultimate tensile stress of mild steel compared to ultimate compressive stress is

(a) same (b) more
(c) less (d) unpredictable

**15.** Poisson's ratio is the ratio of

(a) stress and strain
(b) modulus of elasticity and strain
(c) lateral strain and longitudinal strain
(d) none of these

**16.** Modular ratio of two materials is the ratio of

(a) strains
(b) stress and strain
(c) shear stress and shear strain
(d) modulii and elasticity

**17.** A coil is cut into two halves, the stiffness of cut coils will be

(*a*) double (*b*) half

(*c*) same (*d*) none of these

**18.** Elasticity of a M.S. specimen is defined by

(*a*) Hooke's law (*b*) yield point

(*c*) plastic flow (*d*) proof stress

**19.** When both ends of a column are fixed, the effective length is

(*a*) its own length (*b*) twice its length

(*c*) half its length (*d*) $\frac{1}{\sqrt{2}} \times$ its length

**20.** Slenderness of a column is zero when

(*a*) ends are firmly fixed

(*b*) column is supported on all sides throughout the length

(*c*) length is equal to radius of gyration

(*d*) length is twice the radius of gyration.

**21.** Formula adopted for IS codes is based on

(*a*) Straight line formula

(*b*) Euler's formula

(*c*) Rankine's formula

(*d*) Secant formula

**22.** Principal planes are planes having

(*d*) maximum shear stress

(*b*) no shear stress

(*c*) minimum shear stress

(*d*) none of these

**23.** For a cantilever of span L carrying a moment M at free end, deflection at free end is

(*a*) $\frac{ML^3}{6EI}$ (*b*) $\frac{ML^3}{2EI}$

(*c*) $\frac{ML^3}{8EI}$ (*d*) None of these

**24.** The force acting along the circumference will cause stress in the walls in a direction normal to the longitudinal axis of cylinder, this stress is called

(*a*) longitudinal stress

(*b*) hoop stress

(*c*) yeild stress

(*d*) ultimate stress

**25.** In a cantilever, maximum deflection occurs where

(*a*) bending moment is zero

(*b*) bending moment is maximum

(*c*) shear force is zero

(*d*) slope is zero

**26.** A beam encastered at both the ends is known as

(*a*) simply supported beam

(*b*) over hanging beam

(*c*) a fixed beam

(*d*) a continuous beam

**27.** At the principal planes

(*a*) normal stress is maximum or minimum and the shear stress is zero

(*b*) tensile and compressive stresses are zero

(*c*) tensile stress is zero and the shear stress is maximum.

(*d*) no stress acts.

**28.** Relationship between modulus of elasticity E, modulus of rigidity G is

(*a*) $E = G(1 + \mu)$ (*b*) $G = E(2 - \mu)$

(*c*) $G = \frac{E}{2(1+\mu)}$ (*d*) $G = \frac{E}{1+\mu}$

where $\mu$ = Poisson's ratio

**29.** Torsional rigidity of a solid circular shaft of diameter 'd' is proportional to

(*a*) $d$ (*b*) $d^2$

(*c*) $\frac{1}{d^2}$ (*d*) $d^4$

**30.** The resistance offered by internal stresses to bending is known as

(*a*) shear stress

(*b*) compressive stress

(*c*) modulus of elasticity

(*d*) moment of resistance.

**31.** Bending stress at any section in a beam is

(*a*) equal to section Modulus

(*b*) inversely proportional to section modulus

(*c*) directly proportional to section modulus

(*d*) none of these.

**32.** The Rankine's crippling load is given by

(*a*) $P_R = \frac{f_c A}{1 + a\left(\frac{l}{r}\right)^2}$ (*b*) $P_R = \frac{f_c \times a}{1 + \left(\frac{l}{r}\right)^2}$

(*c*) $P_R = \frac{f_c \times A}{1 + \left(\frac{l}{r}\right)^2}$ (*d*) None of these

**33.** A sudden change in shear force diagram between two points indicates that there is

(*a*) point load at both the points

(*b*) no loading between two points

(*c*) u.d.l. between two point

(*d*) uniformly varying load between two points.

**34.** Effective length of a column of length L fixed at one end and hinged at the other end is

(*a*) L (*b*) 2L

(*c*) $\sqrt{2L}$ (*d*) $\frac{L}{\sqrt{2}}$

**35.** Slope and deflection at a point in a loaded cantilever beam carrying several loads can be found out by the

(*a*) principle of least work

(*b*) moment area method

(*c*) double integration method

(*d*) Macaulay's method

**36.** A composite bar made of steel and copper is heated up. The stresses developed in steel and copper will be

(*a*) compressive land tensile

(*b*) compressives and bending

(*c*) bending and tensile

(*d*) tensile and compressive

**37.** Diagram showing the variation of axial load along the span is

(*a*) Shear force diagram

(*b*) Normal thrust diagram

(*c*) Influence line diagram

(*d*) Bending moment diagram

**38.** Rankine's crippling load formula is valid for

(*a*) long columns only

(*b*) short columns

(*c*) for all columns

(*d*) intermediate columns

**39.** Hoop stress in a thin cylinder of diameter d and thickness t subjected to pressure p will be

(*a*) $\frac{pd}{4t}$ (*b*) $\frac{pd}{t}$

(*c*) $\frac{pd}{2t}$ (*d*) $\frac{2pd}{t}$

**40.** In I-section, the bending moment is resisted mainly by

(*a*) flanges only

(*b*) web only

(*c*) both by flanges and web

(*d*) none of these

**41.** The rate of change of shear force at any section is equal to

(*a*) bending moment (*b*) loading

(*c*) deflection (*d*) intensity of loading

**42.** The section modulus of a circular section about an axis through its *c.g.* is

(*a*) $\frac{\pi d^3}{16}$ (*b*) $\frac{\pi d^3}{32}$

(*c*) $\frac{\pi d^3}{64}$ (*d*) $\frac{\pi d^2}{32}$

**43.** Beams of uniform strength are better as compared to beams of uniform cross section as they are economical

(*a*) for short spans

(*b*) for large spans

(*c*) for heavy weight beams

(*d*) for light weight beams

**44.** A point of contraflexure occurs in a

(*a*) simply supported beam

(*b*) fixed beam

(*c*) cantilever

(*d*) none of these

**45.** Shear force diagram for a cantilever beam carrying a uniformly distributed load over its length is a

(*a*) triangle (*b*) rectangle

(*c*) hyperbola (*d*) parabola

**46.** Shear stress in a rectangular beam exhibits a

(*a*) parabolic variation

(*b*) linear variation

(*c*) cubic variation

(*d*) none of these

**47.** In T-section

(*a*) both flange and web resists in the ratio of the their areas of cross-section

(*b*) only flanges resists shear

(*c*) most of the shear is resisted by web only

(*d*) none of these

**48.** Mohr's circle can be used to determine following stress on inclined surface

(*a*) principal stress

(*b*) normal stress

(*c*) tangential stress

(*d*) maximum shear stress

(*e*) all of these

**49.** For a beam of uniform strength, keeping depth constant, width varies in proportion to

(*a*) $\sqrt{M}$ (*b*) M

(*c*) $M^2$ (*d*) $M^{2/3}$

where M is bending moment

**50.** Section modulus Z is expressed as

(*a*) $\frac{I}{y}$ (*b*) $\frac{E}{I}$

(*c*) $\frac{M}{I}$ (*d*) EI

**51.** For eccentrically loaded strut, the section preferred is

(*a*) solid (*b*) hollow

(*c*) reinforced (*d*) composite

**52.** Maximum strain energy that can be stored in a body is known as

(*a*) impact energy (*b*) resilience

(*c*) proof resilience (*d*) none of these

**53.** Shear stress in beam occurs due to

(*a*) bending moment only

(*b*) pure shear force only

(*c*) torsional force only

(*d*) transverse shear and torsional moments

**54.** A frame in which the number of members is just sufficient to keep it in equilibrium is known as

(*a*) theoretical frame (*b*) perfect frame

(*c*) ideal frame (*d*) deficient frame

**55.** Diamond rivetedjoint can be adopted in

(*a*) butt joint (*b*) double riveted lap joints

(*c*) lap joint (*d*) all types of joints

**56.** Proof stress

(*a*) is the safest stress

(*b*) causes a specified permanent deformation in a material, usually 0.01% or less

(*c*) is used in connection with materials like mild steel

(*d*) does not exist

**57.** The hoop stress of a thick cylinder is considered (*i.e.* it is maximum)

(*a*) near centre

(*b*) at outer radius

(*c*) at inner radius

(*d*) depending on the type of loading

**58.** A uniformally strong beam is one having

(*a*) equal bending stress at all sections

(*b*) equal deflection throughout

(*c*) constant bending mement throughout

(*d*) uniform shear stress

**59.** Compression members tend to buckle in the direction of

(*a*) axis of load

(*b*) perpendicular to the axis of load

(*c*) minimum cross-section

(*d*) least radius of gyration

**60.** The radius taken into consideration in calculating the stress in a hollow shaft subjected to torsion is

(*a*) inner radius

(*b*) outer radius

(*c*) mean radius

(*d*) both inner and outer radii

**61.** Longitudinal stress in a thin cylinder is

(*a*) equal to the hoop stress

(*b*) twice the hoop stress

(*c*) half of the hoop stress

(*d*) one-fourth the hoop stress

**62.** A material having same properties in all directions is known as

(*a*) Orthotropic meterial

(*b*) Isotropic material

(*c*) Elastic material

(*d*) Homogenous material

**63.** A material subjected to reversal of stresses does not fail at a stress known as

(*a*) Fatigue stress (*b*) Proof stress

(*c*) Safe stress (*d*) Endurance stress

**64.** A beam of length $l$, having uniform load of $w$ kg per unit length, is supported freely at the ends. The bending moment at mid span will be

(*a*) $\frac{wl}{4}$ (*b*) $\frac{wl^2}{2}$

(*c*) $\frac{wl^2}{4}$ (*d*) $\frac{wl^2}{8}$

**65.** The moment diagram for a cantilever beam whose free end is subjected to a bending moment will be

(*a*) triangle (*b*) rectangle

(*c*) parabola (*d*) cubic parabola

**66.** Maximum bending moment in a cantilever of length $l$ carrying a uniformly varying load of zero intensity at one end and $w$ N/m at the other end is

(*a*) $\frac{wl^2}{24}$ (*b*) $\frac{wl}{24}$

(*c*) $\frac{wl^2}{6}$ (*d*) None of these

**67.** Number of independent elastic constant for an isotropic, homogeneous and elastic material obeying Hookes law is

(*a*) 1 (*b*) 2

(*c*) 5 (*d*) 6

**68.** If a beam of constant section is subjected throughout its length to a uniform bending moment, it will bend to

(*a*) a circular arc (*b*) a parabolic arc

(*c*) a catenary (*d*) elliptical shape

**69.** A reinforced cement concrete beam is said to be made of

(*a*) homogeneous material

(*b*) heterogeneous material

(*c*) isotropic material

(*d*) all of these

**70.** Twisting couple in a shaft introduces in it

(*a*) bending moment (*b*) deflection

(*c*) shear strain (*d*) shear stress

**71.** If the rivets in adjacent rows are staggered and the outermost row has only one rivet, the arrangement of the rivet is called

(*a*) chain riveting (*b*) zig zag riveting

(*c*) diamond riveting (*d*) criss-cross riveting

**72.** Rankine-Gordon formula is applicable for determining the buckling load for

(*a*) long columns

(*b*) intermediate columns

(*c*) medium size columns

(*d*) intermediate columns, but with certain amendments it can be used for short as well as long columns

**73.** Torsion bars are in parallel

(*a*) if same torque acts on each

(*b*) if they have equal angles of twist and applied torque apportioned between them

(*c*) are not possible

(*d*) if their ends are connected together

**74.** In a beam at a place where the shear force is maximum, the bending moment will be

(*a*) maximum

(*b*) minimum

(*c*) zero

(*d*) neither minimum nor maximum

**75.** Ratio of thickness to diameter for thin cylinder is

(*a*) $\frac{1}{10}$ (*b*) $\frac{1}{15}$

(*c*) $\frac{1}{20}$ (*d*) $\frac{1}{40}$

**76.** The stress induced in a body due to suddenly applied load compared to when it is applied gradually is

(*a*) same (*b*) half

(*c*) two times (*d*) four times

**77.** If the rate of loading is zero, the shear force curve shall

(*a*) vary linearly (*b*) vary parabolically

(*c*) remain constant (*d*) none of these

**78.** If the section modulus of a beam decreases, then the bending stress will

(*a*) decrease

(*b*) increase

(*c*) remain same

(*d*) there is no such correlation

**79.** Points of contraflexure is the point where

(*a*) positive bending moment is maximum

(*b*) negative bending moment is maximum

(*c*) point of zero shear force

(*d*) point of change in sign of bending moment

**80.** Radius of gyration for a circular section is

(*a*) directly proportional to the diameter of the section

(*b*) square root of the diameter of the section

(*c*) inversely proportional to the diameter of the section

(*d*) none of these

**81.** Strain energy stored in a body of volume V with stress s due to gradually applied load is

(*a*) $\frac{sE}{V}$ (*b*) $\frac{sE^2}{V}$

(*c*) $\frac{sV^2}{E}$ (*d*) $\frac{s^2V}{2E}$

**82.** Statically determinate beams are

(*a*) simply supported cantilevers and overhang beams

(*b*) cantilevers and fixed beams

(*c*) continuous beams and beams carrying uniformly distributed loads

(*d*) all of these

**83.** A beam strongest in flexural is one which has

(*a*) maximum bending stress

(*b*) maximum area of cross-section

(*c*) maximum section modulus

(*d*) maximum moment of inertia

**84.** A beam is loaded as cantilever. If the load at the end is increased, the failure will occur

(*a*) in the middle (*b*) at the tip below the load

(*c*) at the support (*d*) anywhere

**85.** When a rectangular beam is loaded transversely, the maximum compressive stress develops on

(*a*) bottom fibre (*b*) top fibre

(*c*) neutral axis (*d*) every cross-section

**86.** When a beam is subjected to a trasverse shearing force, the shear stress in the upper fibres will be

(*a*) maximum (*b*) minimum

(*c*) zero (*d*) depends on other data

**87.** The load at which the column first buckles is known as

(*a*) buckling load (*b*) cryppling load

(*c*) critical load (*d*) any of these

**88.** Rupture stress is

(*a*) breaking stress

(*b*) the stress obtained by dividing the load at the moment of incipient fracture, by the area supporting that load

(*c*) never allowed to reach in members

(*d*) highest stress in a test

**89.** In abeam of uniform strength, if depth is kept constant, then its width varies in proportion to

(*a*) Bending moment (M)

(*b*) $M^2$

(*c*) $\sqrt{M}$

(*d*) $\frac{1}{M}$

**90.** The bulk modulus of a material is defined as the ratio of

(*a*) volume change to modulus of elasticity

(*b*) stress intensity to volumetric strain

(*c*) volume change to original volume

(*d*) pressure applied to the change in volume

**91.** In short columns, failure occurs by

(*a*) pure buckling

(*b*) combination of bending and direct compression

(*c*) direct compression only

(*d*) none of these

**92.** Point of contraflexure in a cantilever of spane $l$, carrying a u.d.l. w/m occurs at

(*a*) mid spane

(*b*) free end

(*c*) fixed end

(*d*) does not exist

**93.** In a rectangular beam, the maximum shear stress occurs at

(*a*) top fibre of the section

(*b*) anywhere cross the depth

(*c*) bottom of the section

(*d*) only at neutral axis

**94.** During the tensile test of a glass rod the nature of stress-strain curve is

(*a*) straight and droping

(*b*) sudden break

(*c*) straight line

(*d*) parabolic

**95.** Ratio of length of column to the minimum radius of gyration of the cross sectional area of the column is known as

(*a*) slenderness ratio (*b*) buckling factor

(*c*) crippling factor (*d*) compressive factor

**96.** Strain rosettes are used to

(*a*) produce strains for testing purpose

(*b*) relieve strain in heavily loaded components

(*c*) measure strain

(*d*) analyse property of materials

**97.** Proof stress

(*a*) is the safest stress

(*b*) cause a specified permanent deformation in a material, usually 0.01% or less

(*c*) is used in connection with materials like mild steel

(*d*) does not exist

**98.** If $\sigma_1$ and $\sigma_2$ be the major and minor tensile stresses, then maximum value of tangential stress is equal to

(*a*) $\sigma_1$ (*b*) $\sigma_2$

(*c*) $\sigma_1 - \sigma_2$ (*d*) $\frac{\sigma_1 - \sigma_2}{2}$

**99.** A long column fails by

(*a*) crushing (*b*) tension

(*c*) shearing (*d*) buckling and crushing

**100.** In Mohr's circle, centre of circle from $y$-axis is taken at

(*a*) $\alpha_x + \sigma_y$ (*b*) $\frac{\sigma_x + \sigma_y}{2} + \tau_{xy}$

(*c*) $\frac{\sigma_x + \sigma_y}{2}$ (*d*) $\frac{\sigma_x - \sigma_y}{2}$

**101.** Shear stress along the principal plane subjected to maximum principal stressl is

(*a*) minimum (*b*) maximum

(*c*) zero (*d*) negative

**102.** Moment of inertia of a square of side d about the diagonal is

(*a*) $\frac{d^4}{12}$ (*b*) $\frac{d^4}{24}$

(*c*) $\frac{d^4}{18}$ (*d*) $\frac{d^4}{8}$

**103.** Maximum shear stress in a body subjected to two perpendicular stress $\sigma_x$, $\sigma_y$ and shear stress $\tau_{xy}$ is equal to

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

(c) $\sqrt{(\sigma_x - \sigma_y)^2 + (\tau_{xy})^2}$ (d) $\sqrt{\frac{(\sigma_x - \sigma_y)^2}{2} + (\tau_{xy})^2}$

**104.** The extremities of any diameter on Mohr's circle represent

(a) principal stresses

(b) normal stresses on planes at 45°

(c) shear stresses on planes at 45°

(d) normal and shear stresses on a plane

**105.** Kern of a circular section of diameter D is a concentric circular area having a diameter of

(a) $\frac{D}{4}$ (b) $\frac{D}{2}$

(c) $\frac{D}{8}$ (d) $\frac{3D}{8}$

**106.** Mohr's circle is used to determine the stresses on an oblique section of body subjected to

(a) direct stresses in two mutually perpendicular directions

(b) a direct stress in one plane along with simple shear stress

(c) direct stresses in two mutually perpendicular directions accompained by a simple shear stress.

(d) all of these.

**107.** The planes of minimum shear stress with reference to principal planes are located at

(a) 0° (b) $22\frac{1}{2}$°

(c) 45° (d) 90°

**108.** The principal stress in the case of pure shear will be equal in magnitude

(a) similar in nature

(b) but opposite in nature

(c) to half the maximum shear stress similar in nature

(d) to half the maximum shear stress but opposite in nature

**109.** Minimum limiting load at which the column tends to have lateral displacement is known as

(a) critical load

(b) crippling load

(c) buckling load

(d) any of these

**110.** A beam is said to be of uniform strength, if

(a) B.M. is same throughout the beam

(b) shear stress is same throughout the beam

(c) deflection is same throughout the beam

(d) bending stress is same at very section along its longitudinal axis.

**111.** A column is defined as short column if

(a) its length is less than 10 m

(b) the ratio of its effective length to the least lateral dimension is less than 15

(c) the ratio of its effective length to least radius of gyration is less than 50

(d) both (a) and (c) above

**112.** Slenderness ratio of a column is the ratio of its

(a) length to least lateral dimension

(b) length to radius of gyration

(c) both (a) and (b) above

(d) lateral dimension to radius of gyration

**113.** In a propped cantilever of span I, carrying a point load w at mid point span, the point of contraflexure shall occur at

(a) $\frac{l}{4}$ from fixed end (b) $\frac{l}{4}$ from free end

(c) $\frac{l}{2}$ from either end (d) $\frac{3l}{4}$ from fixed end

**114.** If a part is constrained to move and heated, it will develop

(a) principal stress (b) tensile stress

(c) compressive stress (d) shear stress

**115.** Most elastic material is

(a) rubber (b) plastic

(c) brass (d) steel

**116.** Compound beams are those in which

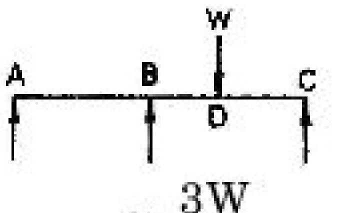
(a) reaction components are more than three

(b) reaction components are three

(c) reaction components are more than three but for each additional reaction components, one hinge is introduced.

(d) none of these.

**117.** For the continuous beam ABC loaded and supported as shown in the figure, the reaction at D shall be




(a) $\frac{W}{2}$ (b) $\frac{3W}{2}$

(c) W (d) zero

**118.** Polar Moment of inertia of a hollow shaft having D and d as outer and inner diameters, is given by

(*a*) $\frac{\pi}{8}(D^4 - d^4)$ (*b*) $\frac{\pi}{32}(D^4 - d^4)$

(*c*) $\frac{\pi}{64}(D^4 - d^4)$ (*d*) $\frac{\pi}{12}(D^4 - d^4)$

**119.** The shear stress produced due to torsion of circular shaft at any section is maximum

(*a*) at outer surfaces

(*b*) at centre of the shaft

(*c*) distance of rp. form the above

(*d*) none of these

**120.** Power transmitted by a circular shaft rotating at N rpm under action of torque T is

(*a*) $\frac{2\pi NT}{750}$ (*b*) $\frac{2\pi NT}{60}$

(*c*) $\frac{2\pi NT}{450}$ (*d*) $\frac{2\pi NT}{4500}$

**121.** Pressure vessels are not made of rectangular shape, because

(*a*) these are difficult to fabricate

(*b*) they are not economical

(*c*) they do not give pleasing appearance

(*d*) it has been practiced to use cylindrical vessels

(*e*) none of these

**122.** Two solid circular shafts having diameters $D_1$ and $D_2$ are subjected to same torque T, the ratio of strain energy stored in the shafts would be

(*a*) $\sqrt{\frac{D_2}{D_1}}$ (*b*) $\sqrt{\frac{D_1}{D_2}}$

(*c*) $\left(\frac{D_1}{D_2}\right)$ (*d*) None of these

**123.** Stress developed in a longitudinal jont in a thin shell of diameter D under the action of an internal pressure p is

(*a*) longitudinal stress

(*b*) radial stress

(*c*) circumferential stress

(*d*) none of these

**124.** Circumferential stress in a thin shell is

(*a*) maximum on inner surface

(*b*) maximum in the middle of thickness

(*c*) maximum in the outer surface

(*d*) remains uniform throughout the thickness

**125.** Ratio of the equivalent length of column to the minimum radius of gyration of the cross-sectional area of the column is called

(*a*) slenderness ratio (*b*) buckling factor

(*c*) column factor (*d*) crippling factor

**126.** The ratio of central deflection due to a central load in the case of a beam freely supported at both ends to the beam fixed at both ends will be

(*a*) $\frac{1}{2}$ (*b*) 2

(*c*) $\frac{1}{4}$ (*d*) 4

**127.** In above bars, if gradually applied load is same, then stored energy will be

(*a*) more in stepped diameter shaft

(*b*) more in uniform diameter shaft

(*c*) equal in both

(*d*) depend on other factors

**128.** Maximum deflection in cantilever due to pure bending moment M at its end is

(*a*) $\frac{Ml^2}{2El}$ (*b*) $\frac{Ml^2}{3El}$

(*c*) $\frac{Ml^2}{4El}$ (*d*) $\frac{MI^2}{6EI}$ $\frac{1}{2}$

**129.** Disruptive strength is the maximum strength of a metal

(*a*) when subjected to three principal tensile stresses at right angles to one another and all of equal magnitude.

(*b*) when loaded in tension

(*c*) when loaded in compression

(*d*) when loaded in shear.

**130.** For eccentrically loaded struts

(*a*) solid members are preferred

(*b*) hollow members are preferred

(*c*) both are equally good

(*d*) reinforced members are preferred

**131.** The Bulk modulus K, the modulus of rigitiy N and Poisson's ratio 1/m are related by

(*a*) $\frac{1}{m} = \frac{9KN}{3K + N}$

(*b*) $\frac{1}{m} = \frac{3K + 2N}{6K - 2N}$

(*c*) $\frac{1}{m} = \frac{6K + 2N}{3K - 2N}$

(*d*) None of these