BYJU'S EXAM PREP

AE/JE Foundation

Mechanical Engineering

Strength of Materials

Top 100
Most Expected Questions

1. A closed coil helical spring is cut into three equal parts and the parts are then connected in series. What is the resultant stiffness of the new configuration?

A. 6k B. k

C. 3k D. 9k

Ans. B

Sol.

Stiffness of spring, $k = \frac{Gd^4}{8D^3n}$

$k \propto \frac{1}{n}$

When spring is cut into 3 parts

$\frac{k_2}{k_1} = \frac{n_2}{n_1} \Rightarrow \frac{k_2}{k} = \frac{3}{1}$

$k_2 = 3k$

Stiffness of each new spring = 3k

Now all three spring is connected in series

$\frac{1}{K_e} = \frac{1}{k_1} + \frac{1}{k_2} + \frac{1}{k_3} + \ldots\ldots\ldots$

$\frac{1}{K_e} = \frac{1}{3k} + \frac{1}{3k} + \frac{1}{3k}$

$k_e = k$

2. A prismatic member subjected to external loading was found to increase in length by 4mm over a length of 1m and consequently its diameter was found to change by 0.002mm. If the initial diameter of the member was 5mm, then calculate the Poisson's ratio of the material.

A. 0.30 B. 0.15

C. 0.23 D. 0.10

Ans. D

Sol. Given,

ΔL = 4mm, L=1m

Δd = -0.002mm, d= 5mm,

$\text{poission's ratio}, \mu = -\frac{\text{lateral strain}}{\text{longitudinal strain}} = \frac{-\frac{\Delta d}{d}}{\frac{\Delta L}{L}}$

$\mu = -\frac{-\frac{0.002}{5}}{\frac{4}{1000}} = 0.1$

3. A cube of volume 27000cc is subjected to a hydrostatic stress of $1400kg/cm^2$. The bulk modulus of the material is $2.5 \times 10^6 kg/cm^2$. Calculate the volume change as a result of the stress applied.

A. 9.45cc B. 15.12cc

C. 23.21cc D. 8.65cc

Ans. B

Sol. Given, V = 27000cc, σ = $1400kg/cm^2$

Bulk modulus, K = $2.5 \times 10^6 kg/cm^2$

$$\text{Bulk modulus}, K = \frac{\sigma}{\left(-\frac{dv}{v}\right)}$$

$$-\frac{dV}{V} = \frac{\sigma}{K} \Rightarrow -\frac{dV}{27000} = \frac{1400}{2.5 \times 10^6}$$

dV = 15.12cc

4. If the ratio of inner diameter (D_i) to outer diameter (D_o) is 2/3, then the ratio of torque carrying capacity of a solid shaft to that of a hollow shaft will be:

(Assume external diameter of both shafts to be equal and the shafts to be made of the same material)

A. 65/81 B. 81/65

C. 16/81 D. 81/16

Ans. B

Sol. Assume both are made up of same material.

Both shaft are made up of same material.

$$\tau_{solid} = \tau_{Hollow}$$

$$\Rightarrow \frac{T_s \times \frac{D_o}{2}}{\frac{\pi}{32} D_o^4} = \frac{T_H \times \frac{D_o}{2}}{\frac{\pi}{32}(D_o^4 - D_i^4)}$$

$$\Rightarrow \frac{T_s}{T_H} = \frac{D_o^4}{(D_o^4 - D_i^4)} = \frac{1}{1 - \left(\frac{D_i}{D_0}\right)^4} = \frac{1}{1 - \left(\frac{2}{3}\right)^4} = \frac{81}{65}$$

So, the correct option is (b).

5. If the Principal stresses on a plane stress problem are S_1 =100 MPa and S_2 = 40 MPa then the magnitude of Mohr circle radius (MPa) will be:

A. 60 B. 50

C. 30 D. None of these

Ans. C

Sol. Mohr circle's radius

$$= \frac{S_1 - S_2}{2} = \frac{100 - 40}{2} = 30 \text{ MPa}$$

If the principle stresses on a plane stress problem are S_1 =100 MPa and S_2 = 40 MPa then the magnitude of Mohr circle radius (MPa) will be 30.

6. What is the hoop stress generated in a thin spherical shell of diameter 120mm and thickness 5mm filled with oil at a pressure of 5MPa?

A. 10MPa
B. 20MPa
C. 30MPa
D. 40MPa

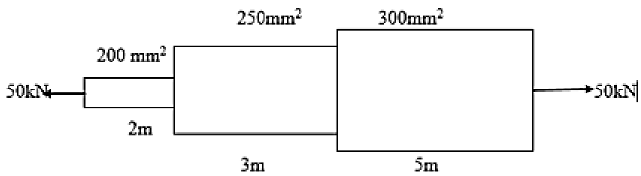
Ans. C

Sol. Hoop stress in sphere = pd/4t

= (5 × 120) / (4 × 5)

= 30MPa

7. Find the total extension in the stepped bar with an axial tensile load of 50 kN and having varying length of 2m, 3m, 5m and area of 200mm^2, 250mm^2 and 300 mm^2 as shown in given figure. E= 2×10^5 N/ mm^2 .



A. 9.67mm
B. 9.82mm
C. 9.78mm
D. 10.67mm

Ans. A

Sol. Total change in length in the stepped bar:

$$\Delta L = \frac{PL_1}{A_1E} + \frac{PL_2}{A_2E} + \frac{PL_3}{A_3E}$$

$$\Delta L = \frac{P}{E}\left(\frac{L_1}{A_1} + \frac{L_2}{A_2} + \frac{L_3}{A_3}\right)$$

$$\Delta L = \frac{50\times10^3}{2\times10^5}\left(\frac{2000}{200} + \frac{3000}{250} + \frac{5000}{300}\right)$$

ΔL = 9.67mm

8. A cantilever beam A with rectangular cross section is subjected to a concentrated load at its free end. If width and depth of another cantilever beam B are twice those of beam A, then the deflection at free end of the beam B compared to that of A will be:

A. 6.25 %
B. 14 %
C. 23.6 %
D. 28 %

Ans. A

Sol.

Deflection for a point load at the free end in the cantilever beam is, $\delta_A = \frac{WL^3}{3EI}$

Where $I_A = \frac{bd^3}{12}$ for rectangular section

$I_B = \frac{(2b)(2d)^3}{12}$

$I_B = 16\ I_A$

Deflection is inversely proportional to moment of inertia. By doubling the width and depth, moment of inertia will become 16 times that of original. So deflection

$\delta_B = \frac{1}{16}\delta_A = 6.25\%\ \delta_A$

9. A cantilever beam of span L is subjected to a moment M at its mid span. The strain energy stored in the beam due to the loading is

A. $\frac{M^2L}{EI}$

B. $\frac{M^2L}{2EI}$

C. $\frac{M^2L}{4EI}$

D. $\frac{M^2L}{8EI}$

Ans. C

Sol.

Strain energy stored in the bar due to moment at mid span = $\int_0^{L/2}\frac{M^2dx}{2EI} = \frac{M^2L}{4EI}$

10. What is the volumetric strain in the thin cylinder subjected to internal pressure having hoop stress of 200 MPa, modulus of elasticity, E=200 GPa and poissons ratio=0.25?

A. 2×10^{-2}

B. 2×10^{-3}

C. 1×10^{-3}

D. 1×10^{-2}

Ans. B

Sol. Given,

Hoop stress = 200 MPa,

modulus of elasticity, E=200 GPa

poisson's ratio=0.25

$$\sigma_H = \frac{Pd}{2t} = 200MPa$$

$$\varepsilon_v = \frac{Pd}{4tE}(5-4\mu) = \frac{1}{2E}\times\frac{Pd}{2t}(5-4\times 0.25)$$

$$\varepsilon_v = \frac{1}{2\times 200\times 10^3}\times 200\times 4$$

$\epsilon_v = 2\times 10^{-3}$

11. For a thin spherical shell subjected to internal pressure, the ratio of volumetric strain to diametrical strain is ____________.

A. 5 : 4

B. 3 : 2

C. 2 : 1

D. 3 : 1

Ans. D

Sol. Volume of sphere

$$V = \frac{\pi}{6} D^3$$

Taking differential on both side

$$\delta V = 3 \times \frac{\pi}{6} \times d^2 \delta d$$

$$\delta V = 3 \times \frac{\pi}{6} d^3 \times \frac{\delta d}{d}$$

$$\delta V = 3 \times V \times \frac{\delta d}{d}$$

$$\frac{\delta V}{V} = 3 \frac{\delta d}{d}$$

So, option D is correct.

12. What is the value of bending stress for a bar of diameter 75 mm for moment of 6.75×10^3 Nm ?

A. 162.92 Mpa

B. 325.95 MPa

C. 625.95 Mpa

D. 651.90 MPa

Ans. A

Sol. **Solution:**

We know that

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

$$\therefore \sigma_b = \frac{6.75 \times 10^6 \times 64}{\pi (75)^4} \times \frac{75}{2}$$

σ_b = 162.92 MPa

13. Resilience of a material is important, when it is subjected to ________.

A. combined loading

B. fatigue

C. thermal stresses

D. shock loading

Ans. D

Sol.

- Resilience is defined as the maximum energy that can be absorbed by a material without creating a permanent distortion.
- Resilience is important property for shock applications such as springs.

14. A uniformly distributed load w (in KN/m) is acting over the entire length of a 2 m long cantilever beam. If the shear force at the midpoint of cantilever is 5 KN. What is the value of w________?

A. 2

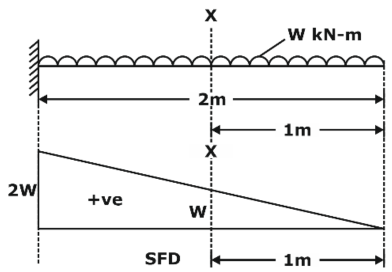
B. 3

C. 4

D. 5

Ans. D

Sol. Shear force at any cross-section X-X of cantilever from free end:



$(S.F)_{x-x} = wx$

The value is given: w = 5 kN at x = 1m

Thus, w × 1 = 5

w = 5 kN

15. When both ends of a column are fixed, the crippling load is F. If one end of the column is made free, the value of crippling load will be changed to ______.

A. F/4
B. F/2
C. F/16
D. 4F

Ans. C

Sol. When both end fixed then effective length = L/2

And when made one end free then effective length = 2L

Crippling load$=\frac{\pi^2 EI}{L^2_e}$

For case 1 F$=\frac{\pi^2 EI}{(0.5L)^2} = \frac{4\pi^2 EI}{L^2}$

For Case 2 Crippling load $F_2 = \frac{\pi^2 EI}{(2L)^2} = \frac{\pi^2 EI}{4L^2} = \frac{F}{16}$

16. The compression members always tend to buckle in the direction of

A. Axis load
B. Perpendicular to the axis of load
C. Minimum cross-section
D. Least radius of gyration

Ans. D

Sol. M.I should be as maximum as possible to resist buckling.

So, chances of buckling is possible about axis having low Moment of Interia.

17. The bar of a boring machine is 45 mm in diameter. During operation, the bar may be twisted through 0.01 radians and subjected to a shear stress of 45 MPa. What is the required length of the bar?

$(take\ G = 0.84\times 10^5\ N/mm^2)$

A. 380 mm
B. 550 mm
C. 420 mm
D. 395 mm

Ans. C

Sol. From the equation to torsion:

$$\frac{T}{J}=\frac{\tau_{max}}{R}=\frac{G\theta}{L}$$

$$\frac{45}{(45/2)}=\frac{0.84\times10^{5}\times0.01}{L}$$

$$2=\frac{0.84\times10^{5}\times0.01}{L}$$

$$L=\frac{0.84\times10^{5}\times0.01}{2}$$

L= 420 mm

18. Find the modulus of elasticity of a rod, which tapers uniformly from 30mmm to 15mm diameter in a length of 300mm. The rod is subjected to axial load of 5kN and extension of rod is 0.022mm.

A. 1.96789×10^{5} N/ mm^2

B. 2.145×10^{5} N/ mm^2

C. 1.92915×10^{5} N/ mm^2

D. 1.8976×10^{5} N/ mm^2

Ans. C

Sol. Given, Large diameter, D_1= 30mm

Small diameter, D_2= 15mm

Length(L) = 300mm

Axial load(P) = 5kN= 5000N

Extension(dl) = 0.022mm

We know that extension for a tapered bar(dl)=

$$=\frac{4PL}{\Pi E D_1 D_2}$$

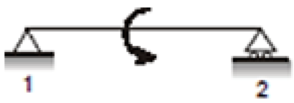
$$0.022=\frac{4\times5000\times300}{\pi E(30)(15)}$$

E= 192915.08N/mm^2= 1.92915×10^{5} N/ mm^2

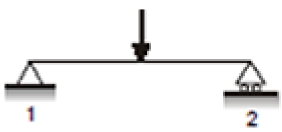
19. Match List-I with List-II and choose the correct answer using the codes given below:

List-I (Loading diagram)

A-



B-

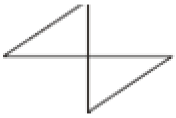


C-

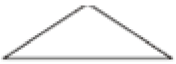
D-

List-II (Bending moment diagram)

1- 

2- 

3- 

4- 

5- 

A. A-4, B-2, C-1, D-3

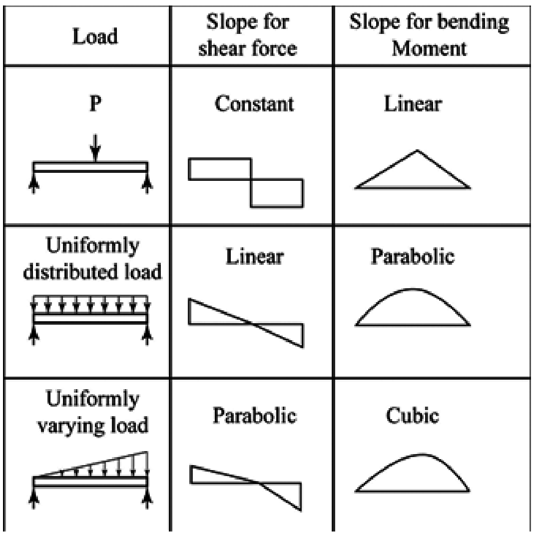
B. A-5, B-1, C-4, D-3

C. A-2, B-5, C-3, D-1

D. A-2, B-4, C-1, D-3

Ans. D

Sol.



Load	Slope for shear force	Slope for bending Moment
P	Constant	Linear
Uniformly distributed load	Linear	Parabolic
Uniformly varying load	Parabolic	Cubic

20. A long column is most likely to fail by ___________.

A. Crushing

B. Tension

C. Shearing

D. Buckling

Ans. D

Sol.

- Long column generally fail by the buckling which is the phenomenon of lateral or horizontal displacement of long columns, which cause their failure.

21. What is the application of determining principle stresses

    A. to ensue the material of same composition

    B. to ensure the safety of structural component

    C. (A) and (B) both

    D. none of these

Ans. B

Sol. to ensure safety of structural component, each and every plane must have stress less than maximum permissible stress i.e. Principle stresses.

22. Consider the following theories of failure:

    A) Maximum stress theory

    B) Maximum strain theory

    C) Maximum shear stress theory

    D) Maximum energy or distortion theory

    The most suitable for ductile material is

    A. A and B   B. A and C

    C. A and D   D. C and D

Ans. D

Sol. 1. Maximum Principal Stress theory also known as RANKINE'S THEORY

2**. Maximum Shear Stress theory** or GUEST AND TRESCA'S THEORY

3. Maximum Principal Strain theory also known as St. VENANT'S THEORY

4. Total Strain Energy theory or HAIGH'S THEORY

5**. Maximum Distortion Energy theory** or VONMISES AND HENCKY'S THEORY "c" and "d" option is correct.

23. A spring has wire diameter d and coil diameter D . If d and D are halved, the resulting deflection will be __________.

    A. half of original deflection   B. Twice of original deflection

    C. four times of original deflection   D. one fourth of original deflection

Ans. B

Sol. Deflection is given by:

$$\delta = \frac{8PD^3 n}{Gd^4}$$

Thus, Deflection is proportional to D^3/d^4.

When both d and D are halved:

$$\delta = \frac{8P\left(\frac{D}{2}\right)^3 n}{G\left(\frac{d}{2}\right)^4} = 2\left(\frac{8PD^3 n}{Gd^4}\right) = 2\delta$$

24. The shear stress in the material at a point is given as 60N/mm^2. Determine the local strain energy per unit volume stored in the material due to shear stress. Take, G= 9×10^4N/mm^2

A. 0.02N/mm^2 B. 0.2N/mm^2

C. 0.1N/mm^2 D. 0.01N/mm^2

Ans. A

Sol. Given,

Shear stress (τ) = 60N/mm^2

Modulus of rigidity (G) = 9×10^4N/mm^2

Strain energy= $\frac{\tau^2}{2G}\times$Volume= $\frac{(60)^2}{2\times9\times10^4}\times$ Volume = 0.02V

Strain energy per unit volume= $\frac{0.02V}{V}$ = 0.02N/mm^2

25. The ratio of elongation of a conical and rectangular bar of same length under its own weight is ___________.

A. 0.5 B. 1

C. 0.33 D. 0

Ans. C

Sol.

Elongation of rectangular bar under its own weight is = $\frac{\gamma L^2}{2E}$

Elongation of conical bar under its own weight is = $\frac{\gamma L^2}{6E}$

Where $\gamma = Unit\ Weight$

Therefore, the ratio:

$$Required\ ratio = \frac{\frac{\gamma L^2}{6E}}{\frac{\gamma L^2}{2E}} = \frac{1}{3} = 0.33$$

26. For a deformable body poisson ratio is defined as the ratio of lateral strain to longitudinal strain. What is the practical limiting value of the poisson's ratio.

A. 0 to 0.5 B. -1 to +1

C. -∝ to + ∝ D. 0 to 1

Ans. A

Sol. • In practical poisson ration range is from 0 to 0.5

• But in theory the value of poisson ratio acceptable range is -1 to +1

27. For a hollow shaft of external and internal diameters 10 cm and 5 cm respectively, the torsional sectional modulus will be approximately _______.

A. 184 cm^3 B. 275 cm^3

C. 368 cm^3 D. 536 cm^3

Ans. A

Sol.

$$\frac{T}{J}=\frac{\tau}{r}=\frac{G\theta}{l}$$

$$\frac{J}{r}=\frac{T}{\tau}=\frac{G\theta}{l}$$

$$\frac{J}{r}=\text{Totrtionala section modulos}$$

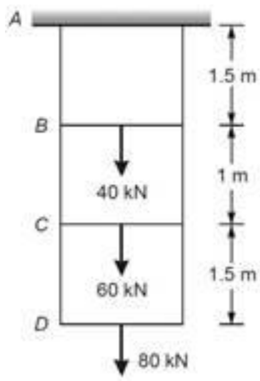
$$J=\frac{\pi(D_1^4-D_2^4)}{32}=\frac{\pi(10^4-5^4)}{32}=920.4$$

$$r=\frac{10}{2}=5\,cm$$

So,

$$\frac{J}{r}=\frac{920.4}{5}=184\,cm^3$$

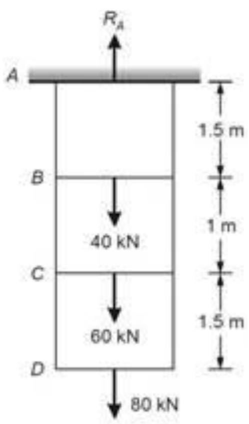
28. A steel bar of 4 m length and uniform cross-sectional area of 1200 mm^2 is suspended vertically and loaded as shown in figure. The elongation of the bar will be
[Take, E = 2.05 × 10^5 N/mm^2]



A. 1.25 mm
B. 2.15 mm
C. 3.15 mm
D. 4.25 mm

Ans. B

Sol.



R_A = 40 + 60 + 80 = 180 kN

Force P_1 on portion AB = 180 kN (tensile)

Force P_2 on portion BC = 180 – 40 = 140 kN (tensile)

Force P_3 on portion CD = 80 kN (tensile)

$$\Delta = \frac{1}{AE}\left(P_1L_1 + P_2L_2 + P_3L_3\right)$$

$$\Delta = \frac{1}{1200 \times 2.05 \times 10^5} \times \left[180 \times 1500 + 140 \times 1000 + 80 \times 1500\right] \times 10^3$$

$$= \frac{530000 \times 10^3}{1200 \times 2.05 \times 10^5} = 2.15 \text{ mm}$$

29. The linear relation between the stress and strain of a material is valid until

A. Fracture stress

B. Elastic limit

C. Ultimate stress

D. Proportional limit

Ans. D

Sol. According to Hook's law stress is directly proportional to strain upto proportional limit.

30. If the principal stresses and the maximum shear stress are of equal magnitude in a Mohr's Circle, the state of stress can be termed as

A. Isotropic

B. Pure shear

C. Uniaxial

D. Generalized plane state of stress

Ans. B

Sol. When the Max shear stress = σ, principal stresses are +σ and −σ, the Mohr's circle is a circle of centre at origin and radius σ and that is pure shear state of stress.

31. Slenderness ratio of column is the ratio of ________.

A. Length to its least radius of gyration

B. Length to its maximum radius of gyration

C. Square root of length to its least radius of gyration

D. Square root of length to its maximum radius of gyration

Ans. A

Sol. Slenderness ratio is given by:

$$S = \frac{L_e}{K} = \frac{Length\ of\ column}{Least\ radius\ of\ gyration}$$

32. A hollow and solid shaft have same outer radii and the ratio of outer and inner radius of hollow shaft is 2:1. if both the shaft is made of same material ,then ratio of the torques of the hollow and solid shaft is

A. 256:1

B. 1:256

C. 16:15

D. 15:16

Ans. D

Sol. Given,

τ_{max} = same ,

diameter ratio for hollow shaft D/d =2

outer diameter of both shaft is same

form the torsion equation

$$\frac{T}{J}=\frac{\tau_{max}}{R_0}=\frac{G\theta}{L}$$

$$T=\frac{J\tau_{max}}{R_0}$$

$$J_S=\frac{\pi}{32}D^4 \ \& \ J_H=\frac{\pi}{32}\left(D^4-d^4\right)$$

$$\frac{T_S}{T_H}=\frac{J_S}{J_H}=\frac{\frac{\pi}{32}D^4}{\frac{\pi}{32}\left(D^4-d^4\right)}=\frac{D^4}{\left(D^4-d^4\right)}$$

$$\frac{T_S}{T_H}=\frac{D^4}{D^4\left(1-\frac{d^4}{D^4}\right)}=\frac{1}{\left(1-\frac{d^4}{D^4}\right)}=\frac{1}{1-\left(\frac{1}{2}\right)^4}$$

$$\frac{T_S}{T_H}=\frac{16}{15} \text{ or } \frac{T_H}{T_S}=\frac{15}{16}$$

33. The stress 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

Ans. C

Sol. **Gradually applied load** is given as σ = (F/A) ------ (F is the gradually applied load)

here, work done is given as (F δL) / 2 and strain energy stored = (σ^2 / 2E) AL

Work done is equal to the strain energy stored.

(F δL) / 2 = (σ^2 / 2E) AL

Therefore, σ = (F/A) ----------- (1)

Suddenly applied load is given as σ = (2F/A), here work done = (F δL)

(F δL) = (σ^2 / 2E) AL

Therefore, σ = (2F/A) ------------- (2)

From (1) and (2), it can be concluded that **suddenly applied load is twice the gradually applied load**.

34. A column with highest equivalent length has _______.

A. Both ends fixed

B. Both ends hinged or pin-joined

C. One end fixed, the other entirely free

D. One end fixed , other end hinged

Ans. C

Sol. A column with highest equivalent length has One end fixed, the other entirely free = 2L

Both fixed= L/2

Both hinged = L

One fixed on hinged = L/√2

35. True stress represents the ratio of ___________.

A. Average load and average are

B. Average load and maximum area

C. Maximum load and maximum area

D. Instantaneous load and instantaneous area

Ans. D

Sol. True stress is defined as the ratio of instantaneous force and instantaneous area.

36. If the principal stress in plane stress problem σ_1 = 200 MPa, σ_2 = 50 MPa, the magnitude of the maximum IN PLANE shear stress (in MPa) will be

A. 125 MPa

B. 100 MPa

C. 75 MPa

D. None of these

Ans. C

Sol. Given,

σ_1 = 200 MPa, σ_2 = 50 MPa

In plane shear stress = $\frac{\sigma_1-\sigma_2}{2} = \frac{200-50}{2}$ = 75 MPa

37. If at a point in a body σ_x = 70 MPa, σ_y = 60 MPa and τ_{xy} = -5 MPa, then the radius of Mohr's circle is equal to.

A. $5\sqrt{5}\,MPa$

B. $2\sqrt{5}\,MPa$

C. $5\sqrt{2}\,MPa$

D. $25MPa$

Ans. C

Sol. Given,

$$\sigma_x = 70\ Mpa, \sigma_y = 60\ Mpa, \tau_{xy} = -5\ Mpa$$

$$Radius\ of\ Mohr's\ circle,$$

$$R = \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau^2{}_{xy}}$$

$$= \sqrt{\left(\frac{70-60}{2}\right)^2 + (-5)^2}$$

$$= \sqrt{25+25}$$

$$= 5\sqrt{2}\ Mpa$$

38. A beam of circular section is subjected to a load of 4kN. If the diameter of the circular section is 0.1m. Calculate the maximum shear stress.

A. 0.5093 N/mm^2 B. 0.68 N/mm^2

C. 0.42 kN/mm^2 D. 0.329 N/mm^2

Ans. B

Sol. Given: F =4kN = 4000N

D = 100mm

r = 50mm

Average shear stress, $\tau_{avg} = \frac{Shear\ force}{Area\ of\ cicular\ section} = \frac{F}{\pi r^2}$

τ_{avg} = 0.5093 N/mm^2

Maximum shear stress for circular section,

$T_{max} = \frac{4}{3}\tau_{avg}$

T_{max} = 0.68 N/mm^2

39. If the young modulus E is equal to bulk modulus K, then the value of Poisson's ratio is

A. 0.33 B. 0.5

C. 0.75 D. none of the above

Ans. A

Sol. Young modulus E and bulk modulus K is related as

E = 3K (1-2μ)

Where,

μ = Poisson ratio

If E = K

$\frac{1}{3}$ = 1-2μ

μ = 0.33

40. The radius of gyration of a double symmetric cross-section pinned-pinned column is 350mm. The distance between two point of contraflexure along its length is 10 m. What is the slenderness ratio of the given column?

A. 42.15 B. 28.57

C. 35 D. 18.56

Ans. B

Sol. Since the column is hinged at both ends.

Thus, Effective length:

l_e = l = 10 m = 10000 mm

radius of gyration (k) = 350 mm

$$\text{slenderness ratio} = \frac{l_e}{k} = \frac{10000}{350} = 28.57$$

41. A structural member subjected to only axial compressive force is called

A. Beam B. Column

C. Frame D. Strut

Ans. D

Sol. A member subjected to only axial compressive force is called a strut. A strut may be horizontal, inclined or even vertical.

A column also primarily carries axial forces but may be subjected to bending and shear stresses as well.

42. A simply supported laterally loaded beam was found to deflect more than a specified value. Which of the following measures will reduce the deflection?

A. Increase the area moment of inertia

B. Increase the span of the beam

C. Select a different material having lesser modulus of elasticity

D. Magnitude of the load to be increased

Ans. A

Sol.

We know, differential equation of flexure for the beam is,

$$EI\frac{d^2y}{dx^2}=M \Rightarrow \frac{d^2y}{dx^2}=\frac{M}{EI}$$

Integrating both sides,

$$\frac{dy}{dx}=\frac{1}{EI}\int M\,dx=\frac{1}{EI}Mx+c_1$$

Again integrating,

$$y=\frac{1}{EI}\left(\frac{Mx^2}{2}\right)+c_1x+c_2 \text{ ...(i)}$$

Where, *y* gives the deflection at the given point.

It is easily shown from the equation (i), If we increase the value of *E* & *I*, then deflection reduces

43. A prismatic bar of length 4m is subjected to an uniaxial pull of 100kN then the magnitude of product of change in diameter to its diameter will be (in μm) take E = 200 GPA, μ = 0.3

A. 0.763

B. 0.567

C. 0.190

D. Can not be determine

Ans. A

Sol. Given, L = 4m, P = 100 kN, E = 200 GPa

μ = 0.3

as we know that,

$$\Delta L=\frac{PL}{AE}=\frac{PL}{\frac{\pi}{4}d^2E}\Rightarrow \Delta L=\frac{4PL}{\pi d^2E}$$

$$\frac{\Delta d}{d}=-\mu\frac{\Delta L}{L}$$

$$\frac{\Delta d}{d} = -\mu \frac{4PL}{\pi d^2 E}$$

$$\Rightarrow (d \times \Delta d) = -\frac{\mu \times 4PL}{\pi E} = -\frac{0.3 \times 4 \times 100 \times 10^3 \times 4}{\pi \times 200 \times 10^9}$$

$(d \times \Delta d) = -0.7639 \times 10^{-6}$m

$(d \times \Delta d) = -0.7639$μm

$|d \times \Delta d| = 0.763$ μm

44. If Poisson's ratio for a material is 0.5, then the elastic modulus for the material is

A. three times its shear modulus

B. for times its shear modulus

C. equal to its shear modulus

D. indeterminate

Ans. A

Sol. $E = 2G(1 + \mu)$

$= 2G(1 + 0.5) = 3G$

45. A beam loaded by a 10kN UDL. The cross-section of the beam is 100×30×1000 mm(b×t×l). Determine the section modulus of the beam?

A. 9010 mm^3

B. 10452 mm^3

C. 12.45 mm^3

D. 15000 mm^3

Ans. D

Sol. Given: width = 100mm thickness = 30 mm

Section modulus, $Z = \frac{Moment\ of\ inertia}{Distance\ of\ outermost\ layer\ from\ Neutral\ axis} = \frac{I}{y_{max}}$

Therefore, $I = \frac{bt^3}{12} = \frac{100 \times 30^3}{12} = 22.5 \times 10^4$ mm^4

$Y_{max} = 15$mm

∴Section modulus, $Z = \frac{22.5 \times (10)^4}{15} = 15000$ mm^3

46. The minimum axial compressive load, P required to initiate buckling for a pinned-pinned slender column with bending stiffness EI and length L is ________.

A. $P = \frac{\pi^2 EI}{4L^2}$

B. $P = \frac{\pi^2 EI}{L^2}$

C. $P = \frac{3\pi^2 EI}{4L^2}$

D. $P = \frac{4\pi^2 EI}{L^2}$

Ans. B

Sol. The Euler's minimum load required to buckle is given by:

$$P_{cr} = \frac{\pi^2 EI}{L_e^2}$$

Where: L_e = effective length of the column.

Pinned-pinned column means hinged on both sides. Thus: $L_e = l$

$$P_{cr} = \frac{\pi^2 EI}{L^2}$$

47. A beam uniformly loaded is simply supported at ends. The deflection at the centre of the beam is 7mm. If both of the simple supports are replaced by fixed supports the new deflection of the resultant beam is

A. 14.0 mm
B. 1.40 mm
C. 3.50 mm
D. 1.75 mm

Ans. B

Sol. For uniformly loaded beam,

$$\delta_{simply\ supported} = \frac{5wL^4}{384EI}$$

$$\delta_{fixed\ supports} = \frac{wL^4}{384EI}$$

Hence,

$$\delta_{simply\ supported} = 5\times\delta_{fixed\ supports}$$

$$\delta_{fixed\ supports} = \frac{7}{5} = 1.4mm$$

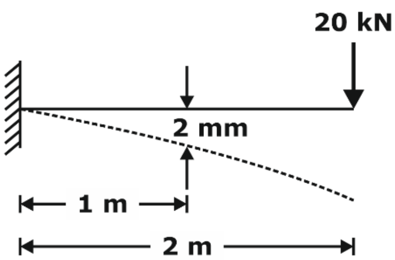
48. The property of the material to regain its original shape after deformation when the external forces are removed is _________.

A. plasticity
B. elasticity
C. durability
D. None of these

Ans. B

Sol. Elasticity is the ability of an object or material to resume its normal shape after being subjected to stretching or compressing force.

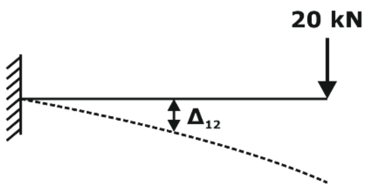
49. For the cantilever beam of span 3 m as shown below, a concentrated load of 20 kN applied at the free end causes a vertical displacement of 2 mm at a section located at a distance of 1 m from the fixed end. If a concentrated vertically downward load of 10 kN is applied at the section located at a distance of 1 m from the fixed end (with no other load on the beam), the maximum vertical displacement in the same beam is _____ mm.

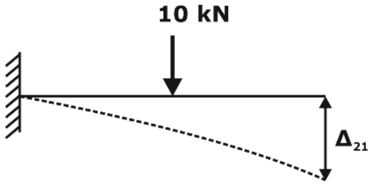


A. 1
B. 2
C. 3
D. 4

Ans. A

Sol.





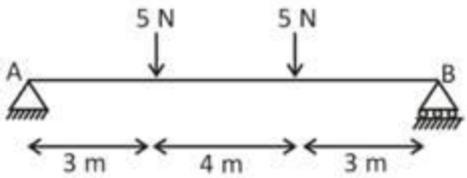
By Maxwell Reciprocal Theorem:

$$F_1 \times \triangle_{12} = F_2 \times \triangle_{21}$$

$$20 \times \triangle_{12} = 10 \times 2$$

$$\triangle_{12} = 1\ mm$$

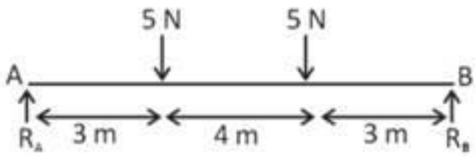
50. A simply supported beam AB is subjected to two point loads of 5N each as shown in the figure below. The bending moment at the mid-point of the beam is_____kNm (correct to one decimal place)



A. 5
B. 15
C. 10
D. 0

Ans. B

Sol.



Calculating the support reactions,

Vertical force equilibrium

$$R_A + R_B = 10N$$

Moment about point A

$R_B \times 10 = 5\times3 + 5\times7 = 15 + 35 = 50$ kN

$$R_B = 5N = R_A$$

Bending moment at the mid-point

BM = $R_B \times 5 - 5 \times 2 = 5\times5 - 5\times2 = 15$

BM = 25 -10 = 15 N-m

51. In a metal forming operation when the material has just started yielding, the principal stresses are $\sigma_1 = +180 MPa, \sigma_2 = -100 MPa, \sigma_3 = 0$. Following Von Mises criterion, the yield stress is _________ MPa.

A. 245.76
B. 240.12
C. 248.57
D. 251.98

Ans. A

Sol. **As per Von-Mises criteria**

$(\sigma_1 - \sigma_2)^2 + (\sigma_1 - \sigma_3)^2 + (\sigma_2 - \sigma_3)^2 = 2\sigma_m^2$

$(180-(-100))^2 + (180-0)^2 + (-100-0)^2 = 2\sigma_m^2$

$\sigma_m = 245.76$ MPa

52. For a power transmission shaft which transmits power P kW at N rpm, then the diameter of the shaft is proportional to.

A. $\left(\frac{P}{N}\right)^{1/3}$
B. $\left(\frac{P}{N}\right)^{1/2}$
C. $\left(\frac{P}{N}\right)^{2/3}$
D. $\frac{P}{N}$

Ans. A

Sol. Power $= \frac{2\pi NT}{60}$

$\therefore \frac{T}{J} = \frac{T}{r}$

$T = \frac{\pi}{16} d^3 \tau$

$P = \frac{2\pi N}{60} \times \frac{\pi}{16} d^3 \tau$

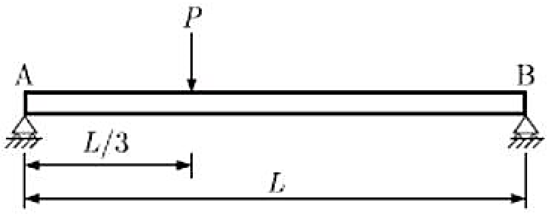
d is proportional to $\left(\frac{P}{N}\right)^{1/3}$

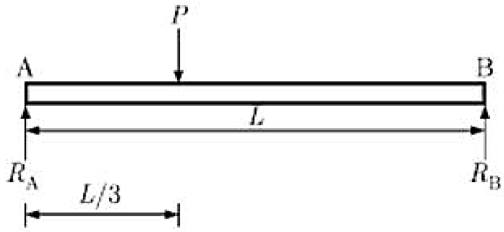
53. A concentrated load of P acts on a simply supported beam of span L at a distance L/3 from the left support. The bending moment at the point of application of the load is given by

A. $\frac{PL}{3}$
B. $\frac{2PL}{3}$
C. $\frac{PL}{9}$
D. $\frac{2PL}{9}$

Ans. D

Sol. We know that, the simplest form of the simply supported on rollers at ends. The simply supported beam and the *FBD* shown in the Figure.





` Where, are the reactions acting at the ends of the beam. In equilibrium condition of forces,

$$P = R_A + R_B \ ...(i)$$

Taking the moment about point *A*,

$$R_B \times L = P \times \frac{L}{3}$$

$$R_B = \frac{P}{3}$$

From equation (i),

$$R_A = P - R_B = P - \frac{P}{3} = \frac{2P}{3}$$

Now bending moment at the point of application of the load

$$M = R_A \times \frac{L}{3} = \frac{2P}{3} \times \frac{L}{3} = \frac{2PL}{9}$$

$$or, M = R_B \times \frac{2L}{3} = \frac{2PL}{9}$$

54. For a circular shaft of diameter d subjected to torque T, the maximum value of the shear stress is.

A. $\frac{64T}{\pi d^3}$

B. $\frac{32T}{\pi d^3}$

C. $\frac{16T}{\pi d^3}$

D. $\frac{8T}{\pi d^3}$

Ans. C

Sol. From the equation of torsion

$$\frac{T}{J} = \frac{\tau_{max}}{d/2}$$

$$\frac{T}{\pi d^4/32} = \frac{\tau_{max}}{d/2}$$

$$\tau_{max} = \frac{16T}{\pi d^3}$$

55. Deformation of a bar due to suddenly applied load 15 mm. If the same load is dropped from a height of 175 cm, then the value of impact factor

A. 16.30
B. 22.62
C. 11.80
D. 14.5

Ans. B

Sol. Given,

$\delta_{\text{suddenly applied}}$ = 15 mm, h = 175 cm = 1.75 m

$\delta_{\text{static}} = \frac{\delta_{\text{suddenly applied}}}{2} = \frac{15}{2}$ = 7.5 mm = 7.5×10^{-3} m

Impact factor = $1 + \sqrt{1 + \frac{2h}{\delta_{\text{static}}}}$

IF = $1 + \sqrt{1 + \frac{2 \times 1.75}{7.5 \times 10^{-3}}}$

IF = 22.62

56. A cylindrical bar of 20 mm diameter and 1 m length is subjected to a tensile test. Its longitudinal strain is 4 times that of its lateral strain. If the modulus of elasticity is 2 x 10^5 N/mm^2 then its modulus of rigidity will be.

A. 18 x 10^6 N/mm^2
B. 28 x 10^6 N/mm^2
C. 80 x 10^5 N/mm^2
D. 0.8 x 10^5 N/mm^2

Ans. D

Sol. Given,

Cylindrical bar = 20 mm diameter,

Modulus of elasticity is 2 x 10^5 N/mm^2

$$Poisson's\ ratio = \frac{\text{Lateral } Strain}{\text{longitudinal } Strain}$$

$$\frac{\text{lateral } Strain}{4 \times \text{lateral } Strain} = 0.25$$

$$But,\ G = \frac{E}{2(1+\mu)} = \frac{2 \times 10^5}{2(1+0.25)}$$

$$= 0.8 \times 10^5\ N/mm^2$$

57. Which of the following statement is correct

A. Long columns fails due to buckling

B. Intermediate columns fail due to combination of both bucking and crushing

C. Short columns fails due to crushing

D. All of the above

Ans. D

Sol.
- Long columns fail due to buckling
- Intermediate columns fail due to combination of both bucking and crushing
- Short columns fail due to crushing

58. A cylinder of internal diameter 3.5 m and thickness 7 cm contains a gas. If the tensile stress in the material is not to exceed 70 N/mm^2, determine the internal pressure of the gas.

A. 2.8 N/mm^2
B. 2.2 N/mm^2
C. 2.4 N/mm^2
D. 2.1 N/mm^2

Ans. A

Sol. Given:

Internal diameter(D) = 3.5 m

Thickness(t) =7 cm=0.07 m

Maximum permissible stress= 70 N/mm^2

As maximum permissible stress is given and it should be equal to circumferential stress(σ_c).

σ_c=70 N/mm^2

Circumferential stress is given by:

$$\sigma_c = \frac{pD}{2t}$$

$$p = \frac{2t \times \sigma_c}{D} = \frac{2 \times 0.07 \times 70 \times 10^6}{3.5}$$

$$p = 2.8 \times 10^6 \ N/m^2 \ = \ 2.8 \ N/mm^2$$

59. A column of length 'L' with both ends fixed may be considered as equivalent to a column of length __________ with both ends hinged.

A. L/8
B. L/2
C. L/4D. L

Ans. B

Sol. For both end fixed ,

Equivalent length of column = 1/2(actual length of column) &

For both end hinged

Equivalent length of column is equal to the actual length of column .

Hence, both the effective lengths are equivalent if length of both end hinged column is reduced to half.

60. What will be the value of Poisson’s ratio, if the elasticity and rigidity of the material is 200 GPa and 66.67 GPa?

A. 0
B. 0.25
C. 0.5
D. 1

Ans. C

Sol.

$$\frac{E}{2G} = \mu + 1 \qquad \mu = \text{ Poisson Ratio}$$

$$\mu = \frac{E}{2G} - 1 = \frac{200}{2 \times 66.67} - 1$$

$$= 1.49 - 1$$

$$= .49 \text{ approx}$$

$$= 0.50$$

61. All the failure theories give nearly the same result __________.

A. When one of the principal stresses at a point is larger in comparison to the other

B. When shear stresses act

C. When both the principal stresses are numerically equal

D. For all situations of stress

Ans. A

Sol. When one of the principle stress at a point is large in comparison to the other, the situation resembles uniaxial tension test. Therefore all theories give nearly same result.

62. A cantilever beam of length L and flexural modulus EI is subjected to a point load P at the free end. The elastic strain energy stored in the beam due to bending (neglecting transverse shear)

A. $\frac{P^2L^3}{6EI}$

B. $\frac{P^2L^3}{3EI}$

C. $\frac{PL^3}{3EI}$

D. $\frac{PL^3}{6EI}$

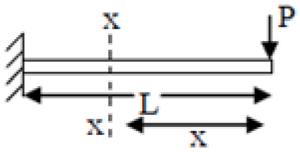
Ans. A

Sol.

$$M_x = -P.x$$

$$\therefore U = \int_0^L \frac{M_x^2 dx}{2EI} = \frac{P^2x^2dx}{2EI}$$

$$U = \frac{P^2L^3}{6EI}$$



63. A helical compression spring made of wire of circular cross-section is subjected to a compressive load. The maximum shear stress induced in the cross-section of the wire is 24 MPA. For the same compressive load, if both the wire diameter and the mean coil diameter are doubled, the maximum shear stress (in MPa) induced in the cross-section of the wire is _______

A. 3

B. 6

C. 9

D. 12

Ans. B

Sol.

$$\tau_{max} = \frac{8P.D}{\pi d^3}$$

Given, $\tau_1 = 24MPa$

$P_1 = P_2$, $d_2 = 2d_1$, $D_2 = 2D_1$

so, $\frac{\tau_1}{\tau_2} = \frac{D_1}{D_2} \cdot \frac{d_2^3}{d_1^3} \Rightarrow \frac{24}{\tau_2} = \frac{1}{2}(2^3)$

$\tau_2 = \frac{24}{4} MPa$

$\therefore \tau_2 = 6MPa$

64. A simply supported beam of 1 m length is subjected to a uniformly distributed load of 0.4 N/m. The maximum bending moment occurring in the beam is ________.

A. 1.0 N-m
B. 0.1 N-m
C. 0.05 N-m
D. 0.025 N-m

Ans. C

Sol. Given:

w= 0.4N/m, L= 1 m

Maximum bending moment under Uniformly distributed load in a simply supported beam, occurs at the centre and is given by:

$$M_{max} = \frac{wL^2}{8}$$

$$M_{max} = \frac{0.4 \times 1^2}{8} = 0.05\ N - m$$

65. At the point of contraflexure ___________.

A. shear force changes its behaviour
B. bending moment changes its behaviour
C. shear force is maximum
D. shear force is minimum

Ans. B

Sol.

- Contraflexture is a location where bending moment is zero or changes its sign.

66. 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

Ans. D

Sol. Modulus of rigidity is defined as the ratio of shear stress to the shear strain.

Hence (D) is correct.

67. If a Mohr Circle is drawn for a fluid element, inside fluid body at rest, It would be

A. A circle with centre at origin

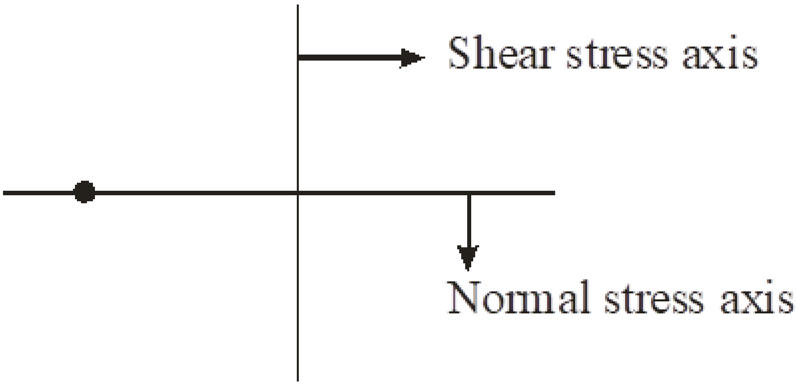
B. A circle with centre on x-axis

C. A point circle on the normal stress axis

D. A point circle on the shear stress axis

Ans. C

Sol.



A fluid element under static condition will have zero shear stress and equal compressive stresses will be present in all the directions, making the required Mohr's circle a point on the normal stress axis .

68. A thin cylinder of diameter 15 mm, thickness 3 mm, pressure 10 N/m^2 and Poisson's ratio 0.5, the longitudinal strain is _________.

A. 37.5

B. 12.5

C. 0.0

D. Data insufficient

Ans. C

Sol. For thin cylinder longitudinal strain is given by:

$$\epsilon_l = \frac{\sigma_l}{E} - \mu\frac{\sigma_h}{E} = \frac{1}{E}\left(\frac{pD}{4t} - \mu\frac{pD}{2t}\right)$$

$$\epsilon_l = \frac{pD}{4tE}(1-2\mu)$$

Since, Poisson's ratio is 0.5.

$$\epsilon_l = \frac{pD}{4tE}(1-2\times 0.5) = 0$$

69. Consider the following theories of failure:

A) Maximum stress theory

B) Maximum strain theory

C) Maximum shear stress theory

D) Maximum energy or distortion theory

The most suitable for ductile material is

A. A and B

B. A and C

C. A and D

D. C and D

Ans. D

Sol. 1. Maximum Principal Stress theory also known as RANKINE'S THEORY

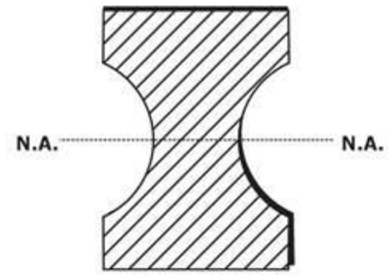
2**. Maximum Shear Stress theory** or GUEST AND TRESCA'S THEORY

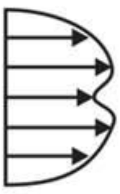
3. Maximum Principal Strain theory also known as St. VENANT'S THEORY

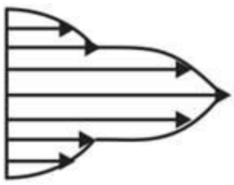
4. Total Strain Energy theory or HAIGH'S THEORY

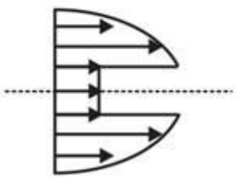
5**. Maximum Distortion Energy theory** or VONMISES AND HENCKY'S THEORY "c" and "d" option is correct.

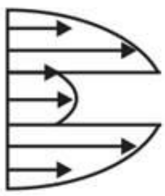
70. Which of the following is the correct shear stress distribution for the rolled section as shown in figure:



A. 

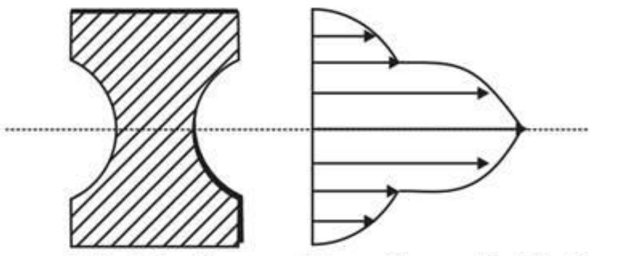
B. 

C. 

D. 

Ans. B

Sol. The shear stress distribution for a rolled section has been shown below:



71. A thin cylindrical pressure vessel with closed-ends is subjected to internal pressure. The ratio of circumferential (hoop) stress to the longitudinal stress is

A. 0.25

B. 0.50

C. 1.0

D. 2.0

Ans. D

Sol. Circumferential stress:

$$\sigma_c = \frac{pD}{2t}$$

Longitudinal stress:

$$\sigma_l = \frac{pD}{4t}$$

where, p is internal pressure d is internal diameter t is thickness.

$$\frac{\sigma_c}{\sigma_l} = \frac{\frac{pD}{2t}}{\frac{pD}{4t}} = 2$$

72. The state of stress at a point under plane stress condition is σ_{xx} = 50 MPa, σ_{yy} = 80 MPa and τ_{xy} = 30 MPa. The diameter of Mohr's circle representing the given state of stress (in MPa) is __________.

A. 33.5 MPa

B. 53 MPa

C. 67 MPa

D. 78 MPa

Ans. C

Sol. Radius of Mohr's circle is given by:

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

$$R = \sqrt{\left(\frac{50-80}{2}\right)^2 + (30)^2} = 33.5410\ MPa$$

Diameter of Mohr's circle :

D = 2R = 2×33.5410 = 67.08 MPa

73. For a bar subjected to moment M = $10x^2 + 21x + 20$, find the shear force acting on the body at x=0

A. 10

B. 20

C. 21

D. 51

Ans. C

Sol. F = dM / dx

F = 20x + 21

At x=0

F = 21

74. 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

Ans. C

Sol. we know that as per the bending equation,ie

$$\frac{M}{I}=\frac{\sigma}{y}=\frac{E}{R}$$,

So as M ie bending moment increases, the stress also increases and the chances of failure increases with it.

Because maximum bending moment occur at fixed end. Hence (C) is correct.

75. At the neutral axis in a beam, there is

A. Maximum tensile stress

B. Maximum compressive stress

C. No bending stress

D. Always stress developed depending on load applied

Ans. C

Sol. At the neutral axis there is no bending stress.

We know bending equation

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

Bending stress, $\sigma = y\frac{E}{R}$

At neutral axis y =0,

$\sigma = 0$

76. The ratio of hoop stress to longitudinal stress in thin walled cylinders is:

A. 1 B. 1/2

C. 2 D. 1/4

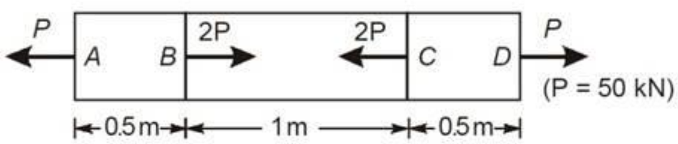
Ans. C

Sol. Hoop stress $(\sigma_h)=\frac{pd}{2t}$

Longitudinal stress $\sigma_L=\frac{pd}{4t}$

$$\frac{\sigma_h}{\sigma_L}=2$$

77. A slender bar of 100 mm^2 cross-section is subjected to loading as shown in the figure. If the modulus of elasticity is taken as 200×10^9 Pa, then the elongation produced in the bar will be _____ mm.



A. 0 B. 0.5

C. 0.75 D. 1

Ans. A

Sol. Given,

Cross-section= 100 mm^2 ,

modulus of elasticity = 200 × 10^9 Pa

Elongation of the bar

$$= \sum \frac{PL}{AE}$$

$$= \frac{P \times 0.5}{AE} - \frac{P \times 1}{AE} + \frac{P \times 0.5}{AE}$$

= 0

78. In thin cylinder the hoop stress is 200 MPa then the maximum shear stress (in plane) is equal to

A. 100 MPa
B. 50 MPa
C. 200 MPa
D. 400 MPa

Ans. B

Sol.

$$\sigma_H = 200MPa$$

$$\sigma_L = \frac{\sigma_H}{2} = \frac{200}{2} = 100MPa$$

$$\tau(in\ plane) = \frac{\sigma_H - \sigma_L}{2} = \frac{200-100}{2} = 50MPa$$

79. In the calculation of induced shear stress in helical springs, the Wahl's correction factor us used to take care of

A. combined effect of transverse shear stress and bending stress in the wire.
B. combined effect of bending stress and curvature of the wire.
C. combined effect of transverse shear stress and curvature of the wire.
D. combined effect of torsional shear stress and transverse shear stress in the wire.

Ans. C

Sol.

- Wahl factor includes the effects of both direct shear and wire curvature. It is given by Wahl factor,

$$K = \frac{4C-1}{4C-4} + \frac{0.615}{C}$$

where C=Spring index= D/d

where D= coil diameter, d= wire diameter

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

A. principal stress
B. tensile stress
C. compressive stress
D. shear stress

Ans. C

Sol. Whenever a body is heated it expands and when allowed to cool it normally contracts. Its the natural behaviour of material. Hence compressive stress is the right answer.

But if a body is restricted to have such changes in dimensions, stresses develop which is proportional to the change of length that is restricted and if expansion is restricted, a compressive stress is believed to be acted upon which compensates that expansion.

81. For a material with the Poisson's ratio μ, the modulus of elasticity (E) and the bulk modulus of elasticity (K) are same. Which of the following is correct?

A. The material has μ = 0
B. The material has μ = 1/2
C. The material has μ = 1/3
D. The material has μ= 3/4

Ans. C

Sol. Given condition is E = K.

so we know that,

$E = 3K (1 - 2\mu)$,

$1 = 3 (1 - 2\mu)$

It means poisons ratio will be 1/3.

82. The torsion bars in parallel have (assume no slipping between bars) ______.

A. Same torque
B. Same angle of twist
C. Same shear stress developed
D. Same torsional rigidity

Ans. B

Sol.

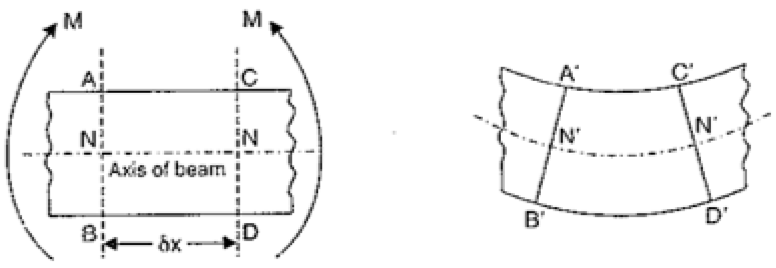
- In parallel combination of shafts, the angle of twist will be same but the torque will not be same.
- In series combination of shafts, torque transmitted will be same and angle of twist will be different.

83. Consider a small length of a beam subjected to simple bending. It has two sections AB and CD normal to the axis of the beam N-N. The amount by which the layer increases or decreases in length,

A. depends on position of top layer w.r.t. bottom layer
B. depends on position of bottom layer w.r.t. top layer
C. depends on position of that layer w.r.t. to neutral axis
D. depends on position of top layer w.r.t. to axis N-N

Ans. C

Sol.



(a) Before bending (b) After bending

`The axis of the beam is the neutral axis.

The amount by which a layer increases or decreases in length, depends upon the position of the layer w.r.t. N-N.

In the above fig. as we move from top layer to N-N, the length of the layer increases. While moving from bottom layer to N-N, the length of the layer decreases.

84. A concentrated load W acts at the centre of a simply supported beam of length L. If the load is changed to a uniformly distributed load over the entire span, then the ratio of maximum deflection under concentrated load and under uniformly distributed load will be

A. 1.2 B. 1.3

C. 1/4 D. 8/5

Ans. D

Sol. in simply supported beam, when concentrated load acts at the centre

Max. deflection, $y_1 = WL^3/48EI$

& for U.D.L, max. deflection, $y_2 = 5WL^3/384EI$ ($\because$ wl=W)

Now, $y_1/y_2 = 384/(5\times48) = 8/5$

85. Rankine's theory is good for____.

A. Brittle material B. Tensile material

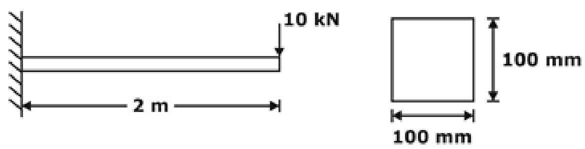
C. Both D. None of them

Ans. A

Sol. Rankine theory is good for brittle material.

For ductile materials Tresca or maximum shear stress criterion and Von Misses Criterion are used.

86. A cantilever beam is subjected to point load of 10 kN at free end. Find the absolute maximum bending stress (in MPa) induced in beam. Cross section of beam is shown below

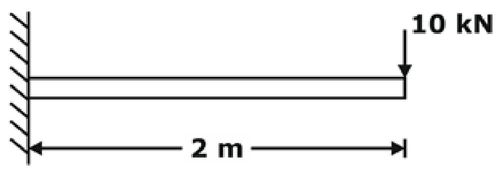


A. 120 MPa B. 240 MPa

C. 60 MPa D. 30 MPa

Ans. A

Sol.



Maximum bending moment will be at the fixed end.

M_{max} = 20 kN-m

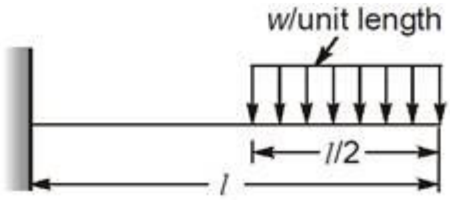
Now, use bending equation:

$$\frac{M}{I} = \frac{\sigma_b}{y}$$

$$\frac{20 \times 10^3}{\frac{(0.1)^4}{12}} = \frac{\sigma_b}{50 \times 10^{-3}}$$

$(\sigma_b)_{max}$ = 120 MPa

87. A uniform cantilever beam with flexural rigidity EI is shown in figure. The bending deflection at the free end is



A. $\frac{47wl^4}{384EI}$

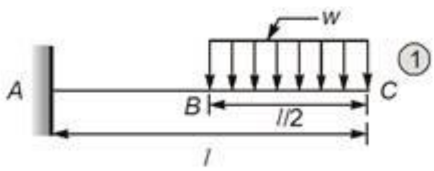
B. $\frac{41wl^4}{384EI}$

C. $\frac{43wl^4}{384EI}$

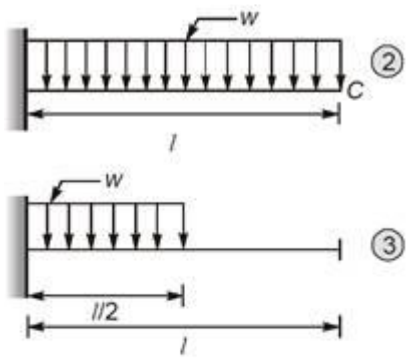
D. $\frac{49wl^4}{384EI}$

Ans. B

Sol.



` By use of superposition principle



` $\delta_1 = \delta_2 - \delta_3$

As we know that:

$$\text{deflection at free end under UDL}, \delta_2 = \frac{wL^4}{8EI}$$

For case (3):

$$\text{Deflection due to (3)}, \delta_3 = \frac{wa^4}{8EI} + \frac{wa^3}{6EI}(L - a)$$

here, a= L/2

$$\delta_3 = \frac{w\left(\frac{L}{2}\right)^4}{8EI} + \frac{w\left(\frac{L}{2}\right)^3}{6EI}\left(L - \frac{L}{2}\right) = \frac{7wL^4}{384EI}$$

$$\delta_1 = \frac{wL^4}{8EI} - \frac{7wL^4}{384EI} = \frac{41wL^4}{384EI}$$

88. Shear force in the beams can be defined as

A. Rate of change of loading

B. Rate of change of bending moment

C. Rate of change concavity

D. None

Ans. B

Sol. Shear force is equal to the rate of change of bending moment. The slope of the bending moment diagram at any point gives the shear force at that point.

89. Ratio of maximum shear stress developed in a rectangular cross-section beam to that developed in a circular cross-section beam for the same average shear stress is

A. 1.33 B. 1.125

C. 2.5 D. 1.5

Ans. B

Sol.

$$\text{maximum shear stress in rectangular beam} = \frac{3}{2} \times \text{average shear stress}$$

$$\text{maximum shear stress in cicular beam} = \frac{4}{3} \times \text{average shear stress}$$

$$\frac{\text{maximum shear stress in rectangular beam}}{\text{maximum shear stress in circular beam}} = \frac{\frac{3}{2} \times \text{average shear stress}}{\frac{4}{3} \times \text{average shear stress}}$$

$$\frac{\text{maximum shear stress in rectangular beam}}{\text{maximum shear stress in circular beam}} = \frac{9}{8} = 1.125$$

90. A thin cylinder of inner radius 500 mm and thickness 5 mm is subjected to an internal gauge pressure of 5 MPa. The average hoop stress in MPa is

A. 100 B. 250

C. 500 D. 1000

Ans. C

Sol. Given,

Inner radius =500 mm

Thickness = 5 mm

Internal pressure = 5 MPa.

$$\sigma_h = \frac{Pd}{2t}$$

$$= \frac{5 \times 1000}{2 \times 5}$$

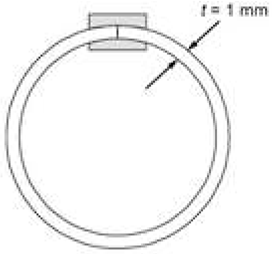
$$= 500\ MPa$$

91. A thin strip of copper (E = 120 GPa) having length L and thickness, t = 1 mm is bent into a circle and held with the ends just touching. The maximum bending stress in the strip is limited to 250 MPa. The length of the strip is

A. 0.24 m
B. 0.68 m
C. 1.5 m
D. 2.5 m

Ans. C

Sol.



Using bending equation,

$$\frac{\sigma}{y} = \frac{E}{R}$$

$$\Rightarrow R = \frac{Ey}{\sigma}$$ (y= thickness/2)

$$= \frac{120 \times 10^3 \times 1}{2 \times 1000 \times 250} = 0.24 \text{ m}$$

Length of the strip $= 2\pi R$

$$= 2\pi \times 0.24 = 1.5 \text{ m}$$

92. A cantilever beam is shown in the figure. Find the magnitude and direction of moment to be applied at free end for zero vertical deflection.

A. 9 kNm clockwise
B. 9 kNm anti-clockwise
C. 12 kNm clockwise
D. 12 kNm anti-clockwise

Ans. C

Sol.

$$\frac{PL^3}{3EI} = \frac{ML^2}{2EI}$$

$$M = \frac{2PL}{3}$$

$$M = 12KNm\ Clockwise$$

93. The power transmitted by two shafts A and B is 10 kW and 30Hp respectively. Keeping all the other conditions same what is the ratio between the torques of A and B.

A. 4/9
B. 1000/3
C. 45/2
D. 2/45

Ans. A

Sol.

$$P_A = \frac{2\pi N T_A}{60} = 10\times 10^3$$

$$P_B = \frac{2\pi N T_B}{60} = 30\times 750$$

Thus,

$T_A/T_B = 4/9$

94. Modulus of resilience in a member is stored strain energy ________.

A. per unit volume
B. in whole volume
C. per unit area
D. per unit length

Ans. A

Sol.

- The modulus of resilience is defined as the maximum energy that can be absorbed per unit volume without creating a permanent distortion.
- The modulus of resilience is the area under the curve up to the yield strength.

95. A 5 m long and 60 mm diameter steel bar is subjected to a tensile load of 100 kN. If the modulus of elasticity for the bar material is 210 GPa, then the modulus of resilience is

A. 0.037
B. 0.3667
C. 0.0029
D. 0.0297

Ans. C

Sol. Cross section area of bar = $A = \frac{\pi}{4}(60)^2 = 2827.43\ mm^2$

Strain energy is given by,

$$U = \frac{P^2L}{2AE} = \frac{(100\times 10^3)^2\times 5000}{2\times 2827.43\times 210\times 10^3} = 42104.5\ N-mm = 42.1\ J$$

Now, modulus of resilience,

$$u = \frac{U}{V} = \frac{42104.5}{2827.43\times 5000} = 0.002978$$

96. Consider a beam with circular cross-section of diameter *d*. The ratio of the second moment of area about the neutral axis to the section modulus of the area is.

A. $\frac{d}{2}$
B. $\frac{\pi d}{2}$
C. d
D. πd

Ans. A

Sol.

$Z = \frac{1}{y}$

$\Rightarrow y = \frac{1}{Z} = \frac{\frac{\pi}{64}d^4}{\frac{\pi}{32}d^3} = \frac{d}{2}$

97. A solid shaft transmits 42 kW power at 700 rad/s. Calculate the torque transmitted.

A. 10 Nm
B. 100 Nm
C. 600 Nm
D. 60 Nm

Ans. D

Sol. Given,'

power, P = 42 kW,

angular speed, ω = 700rad/s

P=T×ω

42×10^3 = T×700

T = 60N-m

98. The materials having same elastic properties in all directions are called: -

A. ideal materials
B. uniform materials
C. isotropic material
D. practical materials

Ans. C

Sol. Isotropic Material is defined as if its mechanical and thermal properties are the same in all directions.

Homogeneous material have same chemical composition, so isotropic and homogeneous are different things.

In context to the given question, isotropic is the correct answer.

99. In the engineering stress-strain curve for mild steel, the Ultimate Tensile Strength (UTS) refers to

A. Yield stress
B. Proportional limit
C. Maximum stress
D. Fracture stress.

Ans. C

Sol. Ultimate tensile strength (UTS) is the maximum stress that a material can withstand while being stretched or pulled. UTS is the final amount of stress sustained in a tensile test at the exact moment the object ruptures

100. Which type of support has a reaction and a bending moment components?

A. Hinge support
B. Roller support
C. Fixed support
D. None of these

Ans. C

Sol. Fixed supports can resist vertical and horizontal forces as well as a moment. Since they restrain both rotation and translation, they are also known as rigid supports.

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