QUESTION BANK

1. The stretch in a steel rod of circular section, having a length L subjected to a tensile load P and tapering uniformly from a diameter d_1 at one end to a diameter d_2 at the other end, is given by

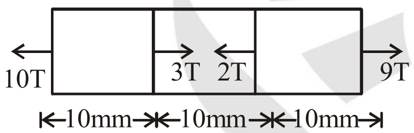
(a) $\frac{PL}{4Ed_1d_2}$ (b) $\frac{PL\pi}{Ed_1d_2}$

(c) $\frac{PL\pi}{4Ed_1d_2}$ (d) $\frac{4PL}{\pi Ed_1d_2}$

2. The total extension of the bar loaded as shown in the figure is

A = area of cross-section

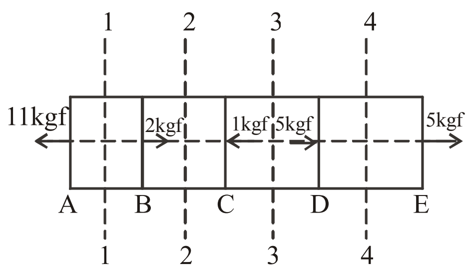
E = modulus of elasticity



(a) 10 × 30/AE (b) 26 × 10/AE

(c) 9 × 30/AE (d) 30 × 22/AE

3. A bar of uniform cross-section of one sq. cm is subjected to a set of five forces as shown in the given figure, resulting in its equilibrium. That maximum tensile stress (in kgf/cm^2) produced in the bar is



(a) 1 (b) 2

(c) 10 (d) 11

4. A 10 cm long and 5 cm diameter steel rod fits snugly between two rigid walls 10 cm apart at room temperature. Young's modulus of elasticity and coefficient of linear expansion of steel are 2×10^6 kgf/cm^2 and 12×10^{-6}/°C respectively. The stress developed in the rod due to a 100°C rise in temperature wall be

(a) 6×10^{-10} kgf/cm^2 (b) 6×10^{-9} kgf/cm^2

(c) 2.4×10^3 kgf/cm^2 (d) 2.4×10^4 kgf/cm^2

5. For a composite bar consisting of a bar enclosed inside a tube of another material and when compressed under a load W as a whole through rigid collars at the end of the bar. The equation of compatibility is given by (suffixes 1 and 2 refer to bar and tube respectively)

(a) $W_1 + W_2 = W$

(b) $W_1 + W_2 =$ Constant

(c) $\frac{W_1}{A_1E_1} = \frac{W_2}{A_2E_2}$

(d) $\frac{W_1}{A_1E_2} = \frac{E_2}{A_2E_1}$

6. A tapering bar (diameter of end sectisons being, d_1 and d_2) and a bar of uniform cross-section 'd' haved thesame length and are subjected the same axial pull. Both the bars will have the same extension if 'd' is equal to

(a) $\frac{d_1 + d_2}{2}$ (b) $\sqrt{d_1d_2}$

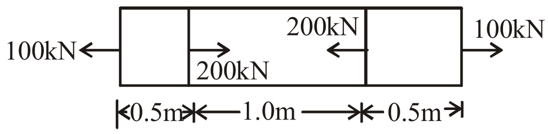
(c) $\sqrt{\frac{d_1 + d_2}{2}}$ (d) $\sqrt{\frac{d_1 + d_2}{2}}$

7. The deformation of a bar under its own weight as compared to that when subjected to a direct axial load equal to its own weight will be

(a) the same (b) one fourth

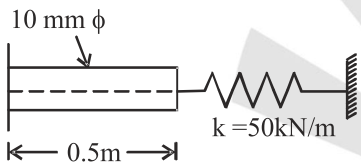
(c) half (d) double

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



(a) 10 mm (b) 5 mm
(c) 1 mm (d) nil

9. If the rod fitted snugly between the supports as shown in the figure below, is heated, the stress induced in it due to 20°C rise in temperature will be ($\alpha = 12.5 \times 10^{-6}$/°C) and E = 200 GPa)

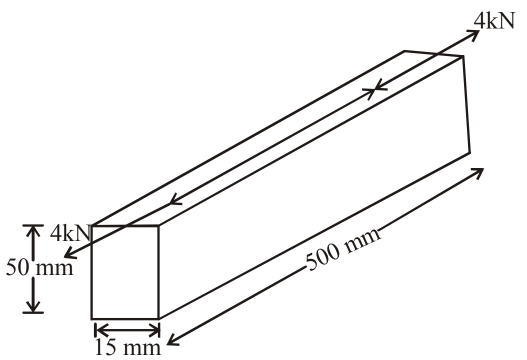


(a) 0.07945 MPa (b) –0.07945 MPa
(c) –0.03972 MPa (d) 0.03972 MPa

10. A rod of material with E = 200×10^3 MPa and $\alpha = 10^{-3}$ mm/mm°C is fixed at both the ends. It is uniformly heated such that the increase in temperature is 30°C. The stress developed in the rod is

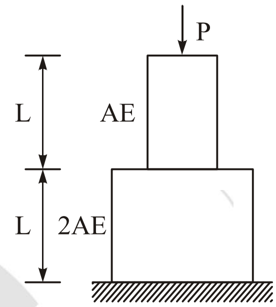
(a) 6000 N/mm^2 (tensile)
(b) 6000 N/mm^2 (compressive)
(c) 2000 N/mm^2 (tensile)
(d) 2000 N/mm^2 (compressive)

11. A link is under a pull which lies on one of the faces as shown in the figure below. The magnitude of maximum compressive stress in the link would be



(a) 21.3 N/mm^2 (b) 16.0 N/mm^2
(c) 10.7 N/mm^2 (d) Zero

12. The axial movement of top surface of stepped column as shown in figure is



(a) 2.5 PL/AE (b) 3 PL/AE
(c) 1.5 PL/AE (d) 2LP/AE

13. The principle of superposition is made use of in structural computations when:

(a) The geometry of the structure changes by a finite amount during the application of the loads
(b) The changes in the geometry of the structure during the application of the loads is too small and the strains in the structure are directly proportional to the corresponding stresses
(c) The strains in the structure are not directly proportional to the corresponding stresses, even though the effect of changes in geometry can be neglected.
(d) None of the above conditions are met.

14. A cantilever beam of tubular section consists of 2 materials copper as outer cylinder and steel as inner cylinder. It is subjected to a temperature rise of 20°C and $\alpha_{copper} > \alpha_{steel}$. The stresses developed in the tubes will be

(a) Compression is steel and tension in copper
(b) Tension in steel and compression in copper
(c) No stress in both
(d) Tension in both the materials

15. In a linear elastic structural element

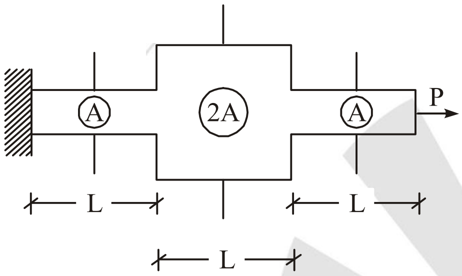
(a) Stiffness is directly proportional to flexibility

(b) Stiffness is inversely proportional to flexibility

(c) Stiffness is equal to flexibility

(d) Stiffness and flexibility are not related

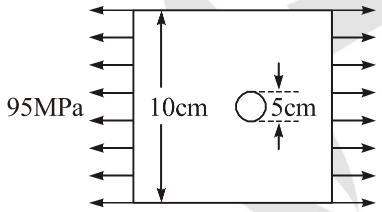
16. The total elongation of the structural element fixed, at one end, free at the other end, and of varying cross-section as shown in the figure when subjected to a force p at free end is given by



(a) PL/AE (b) 3 PL/AE

(c) 2.5 PL/AE (d) 2PL/AE

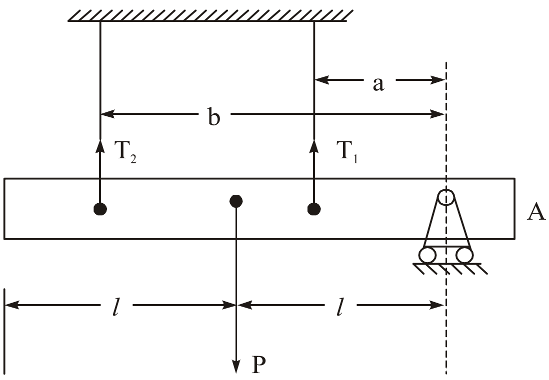
17. A large uniform plate containing a rivet-hole is subjected to uniform uniaxial tension of 95 MPa. The maximum stress in the plate is



(a) 100 MPa (b) 285 MPa

(c) 190 MPa (d) Indeterminate

18. Below Fig. shows a rigid bar hinged at A and supported in a horizontal position by two vertical identical steel wires. Neglect the weight of the beam. The tension Tl and T2 induced in these wires by a vertical load P applied as shown are



(a) $T_1 = T_2 = \frac{P}{2}$

(b) $T_1 = \frac{Pal}{(a^2+b^2)}, T_2 = \frac{Pbl}{(a^2+b^2)}$

(c) $T_1 = \frac{Pbl}{(a^2+b^2)}, T_2 = \frac{Pal}{(a^2+b^2)}$

(c) $T_1 = \frac{Pal}{2(a^2+b^2)}, T_2 = \frac{Pbl}{2(a^2+b^2)}$

19. A rod of length 'l' and cross-section area 'A' rotates about an axis passing through one end of the rod. The extension produced in the rod due to centrifugal forces is (w is the weight of the rod per unit length and ω is the angular velocity of rotation of the rod.)

(a) $\frac{\omega w l^2}{gE}$ (b) $\frac{\omega^2 w l^3}{3gE}$

(c) $\frac{\omega^2 w l^3}{gE}$ (d) $\frac{3gE}{\omega^2 w l^3}$

20. In the case of an engineering material under unidirectional stress in the x-direction, the Poisson's ratio is equal to (symbols have the usual meanings)

(a) $\frac{\varepsilon_y}{\varepsilon_x}$ (b) $\frac{\varepsilon_y}{\sigma_x}$

(c) $\frac{\sigma_y}{\sigma_x}$ (d) $\frac{\sigma_y}{\varepsilon_x}$

21. A free bar of length L is uniformly heated form 0°C to a temperature t°C. α is the coefficient of linear expansion and E the modulus of elasticity. The stress in the bar is

(a) αtE

(b) $\alpha tE/2$

(c) zero

(d) none of the above

22. Which one of the following pairs is NOT correctly matched?

(E = Young's modulus, a = Coefficient of linear expansion, T = Termperature rise, A = Area of cross-section, 1 = Original length)

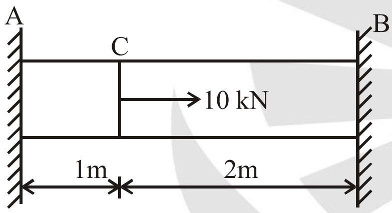
(a) Temperature strain with permitted expansion δ .... $(\alpha Tl - \delta)$

(b) Temperature stress .... αTE

(c) Temperature thrust.... αTEA

(d) Temperature stress with permitted expansion δ.... $\dfrac{E(\alpha Tl - \delta)}{l}$

23. The reactions at the rigid supports at A and B for the bar loaded as shown in the figure are respectively.



(a) 20/3 kN, 10/3 KN

(b) 10/3 kN, 20/3 kN

(c) 5 kN, 5 kN

(d) 6 kN, 4 kN

24. A steel rod of diameter 1 cm and 1 m long is heated from 20°C to 120°C. Its $\alpha = 12 \times 10^{-6}$/K and E = 200 GN/m^2. If the rod is free to expand, the thermal stress developed in it is:

(a) 12×10^4 N/m^2 (b) 240 kN/m^2

(c) zero (d) infinity

25. A steel rod 10 mm in diameter and 1m long is heated from 20°C to 120°C, E = 200 GPa and a = 12×10^{-6} per °C. If the rod is not free to expand, the thermal stress developed is:

(a) 120 MPa (tensile)

(b) 240 MPa (tensile)

(c) 120 MPa (compressive)

(d) 240 MPa (compressive)

26. A heavy uniform rod of length 'L' and material density 'δ' is hung vertically with its top end rigidly fixed. How is the total elongation of the bar under its own weight expressed?

(a) $\dfrac{2\delta L^2 g}{E}$ (b) $\dfrac{\delta L^2 g}{E}$

(c) $\dfrac{\delta L^2 g}{\sqrt{2}E}$ (d) $\dfrac{\delta L^2 g}{2E}$

27. Given that for an element in a body of homogeneous isotropic material subjected to plane stresses. If ε_x, ε_y and ε_z are normal strains in x, y and z direction respectively and μ is the poisson's ratio, the magnitude of unit volume change of the element is given by

(a) $\varepsilon_x + \varepsilon_y + \varepsilon_z$ (b) $\varepsilon_x + \mu(\varepsilon_y + \varepsilon_z)$

(c) $\mu(\varepsilon_x + \varepsilon_y + \varepsilon_z)$ (d) $\dfrac{1}{\varepsilon_x} + \dfrac{1}{\varepsilon_y} + \dfrac{1}{\varepsilon_z}$

28. A solid metal bar of uniform diameter D and length L is hung vertically from a ceiling. If the density of the material of the bar is ρ and the modulus of elasticity is E, then the total elongation of the bar due to its own weight is

(a) $\dfrac{\rho L}{2E}$ (b) $\dfrac{\rho L^2}{2E}$

(c) $\dfrac{\rho E}{2L}$ (d) $\dfrac{\rho E}{2L^2}$

29. A bar of circular cross-section varies uniformly from a cross-section 2D to D. If extension of the bar is calculated treating it as a bar of average diameter, then the perentage error will be

(a) 10 (b) 25

(c) 33.33 (d) 50

30. The length, coefficient of thermal expansion and young's modulus of bar A are twice that of bar B. If the temperature of both bars is increased by the same amount while preventing any expansion, then the ratio of stress developed in bar A to that in bar B will be

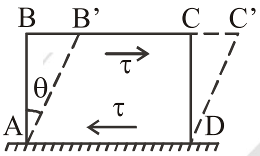
(a) 2 (b) 4

(c) 8 (d) 16

31. The side AD of the square block ABCD as shown in the given figure is fixed at the base and it is under a stage of simple shear causing shear stress τ and shear strain ϕ.

where $\phi = \dfrac{\tau}{\text{Modulus of Rigidity (G)}}$

The distored shape is AB'C'D. The diagonal strain (linear) will be



(a) $\phi/2$ (b) $\phi/\sqrt{2}$

(c) $\sqrt{2}\phi$ (d) ϕ

32. The lists given below refer to a bar of length L cross sectional area A, Young's modulus E, poisson's ratio μ and subjected to axial stress 'p'.

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

List-I	List-II
A. Volumetric strain	**1.** $2(1+\mu)$
B. Strain energy per unit volume	**2.** $3(1-2\mu)$
C. Ratio of young's modulus to bulk modulus	**3.** $\frac{p}{E}(1-2\mu)$
D. Ratio of young's modulus to modulus of rigidity	**4.** $\frac{p^2}{2E}$
	5. $2(1-\mu)$

Codes:	A	B	C	D
(a)	3	4	2	1
(b)	5	4	1	2
(c)	5	4	2	1
(d)	2	3	1	5

33. If all the dimensions of a prismatic bar of square cross-section suspended freely from the ceiling of a roof are doubled then the total elongation produced by its own weight will increase

(a) eight times (b) four times

(c) three times (d) two times

34. ***Asseriton (A):*** The amount of elastic deformation at a certain point, which an elastic body undergoes, under given stress is the same irrespective of the stresses being tensile or compressive.

Reason (R) : The modulus of elasticity and Poisson's ratio are assumed to be the same in tension as well as compression.

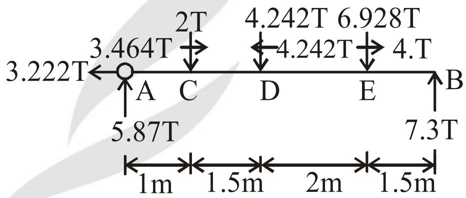
(a) Both A and R are true and R is the correct explanation of A

(b) Both A and R are true but R is not a correct explanation of A

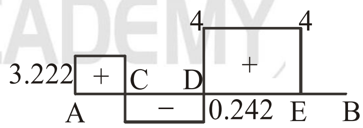
(c) A is true but R is false

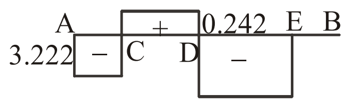
(d) A is false but R is true

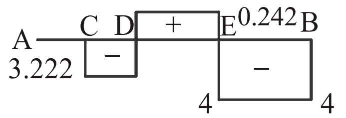
35. If the loads and reactions of the beam shown are as given in the following figure.

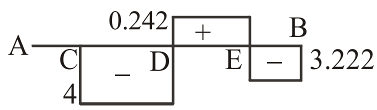


The thrust diagram on the section of the beam, taking tension positive, will be

(a) 

(b) 

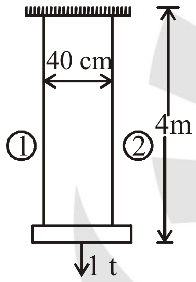
(c) 

(d) 

36. A copper bar of 25 cm length is fixed by means of supports at its ends. Supports can yield (total) by 0.01 cm. If the temperature of the bar is raised by 100°C, then the stress induced in the bar for $\alpha_c = 20 \times 10^{-6}$ °C and $E_c = 1 \times 10^6$ kg/cm^2 wil be

(a) 2×10^2 kg/cm^2 (b) 4×10^2 kg/cm^2
(c) 8×10^2 kg/cm^2 (d) 16×10^2 kg/cm^2

37. Two wires of equal length are suspended vertically at a distance of 40 cm as shown in the figure below. Their upper ends are fixed to the ceiling while their lower ends support a rigid horizontal bar which carries a central load of 1t midway between the wires. Details of the wires are given below:

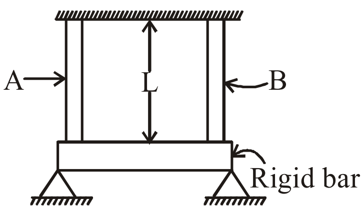


Wire No.	Area (cm^2)	Material	Modulous of Elasticity (kg/cm^2)	Elongation
1	4	Copper	1×10^6	Δ_c
2	2	Steel	2×10^6	Δ_s

The ratio of the elongation of the two wires, Δ_c/Δ_s is

(a) 0.025 (b) 0.5
(c) 2 (d) 1

38. A composite section shown in the figure below was formed at 20°C and was made of two materials A and B. If the coefficient of thermal expansion of A is greater than that of B and the composite section is heated to 40°C, then A and B will



(a) be in tension and compression respectively
(b) both be in compression
(c) both be in tension
(d) be in compression and tension respectively

39. A mild steel bar is in two parts having equal lengths. The area of cross-section of part-1 is double that of Part-2. If the bar carries an axial load P, then the ratio of elongation in Part-1 to that in Part-2 will be

(a) 2 (b) 4
(c) 1/2 (d) 1/4

40. ***Asseriton (A):*** A bar tapers from a diameter of 'd_1' to a diameter of 'd_2' over its length L and is subjected to a tensile force P. If extension is calculated based on treating it as a bar of average diameter, the calculated extension will be more than the actual extension.

Reason (R): The actual extension in such bars is given by, $\Delta = \dfrac{4PL}{\pi d_1 d_2 E}$.

(a) Both A and R are true and R is the correct explanation of A
(b) Both A and R are true but R is not a correct explanation of A
(c) A istrue but R is false
(d) A is false but R is true

41. A round bar made of same material consists of 3 parts each of 100 mm length having diameters of 40 mm, 50 mm and 60 mm, respectively. If the bar is subjected to an axial load of 10 kN, the total elongation of the bar in mm would be (E is the modulus of elasticity in kN/mm^2)

(a) $\dfrac{0.4}{\pi E}\left(\dfrac{1}{16}+\dfrac{1}{25}+\dfrac{1}{36}\right)$

(b) $\dfrac{4}{\pi E}\left(\dfrac{1}{16}+\dfrac{1}{25}+\dfrac{1}{36}\right)$

(c) $\dfrac{4\sqrt{2}}{\pi E}\left(\dfrac{1}{16}+\dfrac{1}{25}+\dfrac{1}{36}\right)$

(d) $\dfrac{40}{\pi E}\left(\dfrac{1}{16}+\dfrac{1}{25}+\dfrac{1}{36}\right)$

42. If a member is subjectd to tensile stress of 'p_x', compressive stress of 'p_y' and tensile stress of 'p_z', along the X, Y and Z directions respectively, then the resultant strain 'e_x' along the X direction would be (E is Young's modulus of elasticity, 'μ' is Poisson's ratio)

(a) $\frac{1}{E}(p_x + \mu p_y - \mu p_z)$

(b) $\frac{1}{E}(p_x + \mu p_y + \mu p_z)$

(c) $\frac{1}{E}(p_x - \mu p_y + \mu p_z)$

(d) $\frac{1}{E}(p_x - \mu p_y - \mu p_z)$

43. A steel bar 300 mm long and having 24 mm diameter, is turned down to 18 mm daimeter for one third of its length. It is heated 30°C above room temperature, clamped at both ends and than allowed to cool to room temperature. If the distance betwen the clamps is unchanged, the maximum stress in the bar ($\alpha = 12.5 \times 10^{-6}$ per °C and E = 200 GN/m^2) is

(a) 25 MN/m^2

(b) 50 MN/m^2

(c) 75 MN/m^2

(d) 100 MN/m^2

❍❍❍

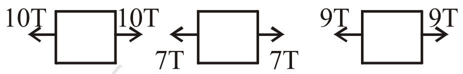
ANSWERS AND EXPLANATIONS

1. *Ans. (d)*

Deflection of circular tapering rod subjected to tensile load P. is

$$\delta L = \frac{4PL}{\pi d_1 d_2 E}$$

2. *Ans. (b)*

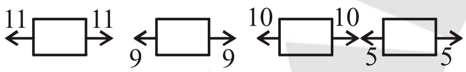


$$(\delta l)_{total} = (\delta l)_1 + (\delta l)_2 + (\delta l)_3$$

$$= \frac{10\times10}{AE} + \frac{7\times10}{AE} + \frac{9\times10}{AE} = \frac{26\times10}{AE}$$

3. *Ans. (d)*

F.B.D

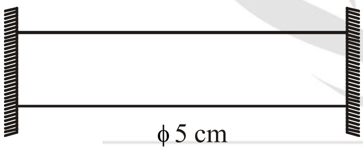


Maximum tensile force = 11 kg.f

Max. tensile stress = $\frac{11}{1\times1}$

= 11 kg/cm^2

4. *Ans. (c)*



ϕ 5 cm

l = 10 cm

E = 2 × 10^6 kgf/cm^2

α = 12 × 10^{-6} / °c

$\because$ Strain is prevented stress will be induced in steel rod.

It is satically indeterminate. So we used one equation of compatibility.

$$L\ \alpha\ \Delta T = \frac{PL}{AE}$$

$$\sigma = E\ \alpha\ \Delta T = 12 \times 10^{-6} \times 2 \times 10^6 \times 100$$

$$= 2.4 \times 10^3 \text{ kgf/cm}^2$$

5. *Ans. (c)*

(Strain)$_1$ = (strain)$_2$

$$\therefore \quad \frac{W_1}{A_1E_1} = \frac{W_2}{A_2E_2}$$

6. *Ans. (b)*

$$\Delta l = \frac{4pl}{E\pi d_1 d_2}$$

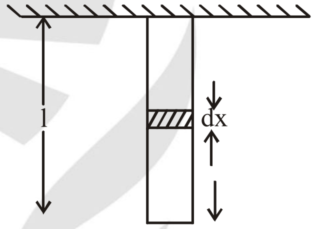
$$= \frac{pl}{E\left(\frac{\pi d_1 d_2}{4}\right)} = \frac{pl}{E\times \text{Area}}$$

$$\therefore \text{ Area} = \frac{\pi}{4}(d_{eq})^2 = \frac{\pi}{4}d_1d_2$$

$$\therefore \quad \boxed{d_{eq} = \sqrt{d_1 d_2}}$$

7. *Ans. (c)*

Deformation under own weight



Consider a small strip 'dx' at a distance 'x' as shown in figure. We shall find change in length for 'dx' and then integrate for whole length. Force exerted by weight below strip 'dx'

Force (P) = Volume below 'dx' × specific weight

= A × p (A = cross – sectional area)

Elongation of the strip

$$(\delta l)_{dx} = \frac{(A\times l)dx}{A\times E} \qquad \begin{bmatrix}\text{load} = A\times p\\ \text{length} = dx\end{bmatrix}$$

$$(\delta l)_{dx} = \frac{\rho x dx}{E}$$

For total elongation integrate and take limits

$$\delta l = \int_o^l \frac{\rho}{E} x dx = \frac{\rho}{E}\left(\frac{x^2}{2}\right)_o^l$$

$$\delta l = \frac{\rho l^2}{2E} \qquad \text{...(i)}$$

Now elongation due to load (W)

$$\delta l = \frac{Wl}{AE}$$

load = own weight (givne)

W = ρlA

$$\therefore\ A = \frac{W}{\rho l}$$

$$\therefore\ (\delta l)_w = \frac{\rho l^2}{E} \qquad ...(ii)$$

Now from equation (i) and (ii)

Where, δl = Elongation due to self load (w)

$(\delta l)_w$ = Elongation externel due to load w

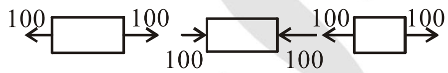
$$\frac{\delta l}{\delta l_w} = \frac{1}{2}$$

$$\therefore \qquad \boxed{\delta l = \delta l_w / 2}$$

8. ***Ans. (d)***

F.B.D.

$$\left(\delta = \frac{PL}{AE}\right)$$



total elongation

$$= \frac{1}{AE}(100 \times 0.5 - 100 \times 1 + 100 \times 0.5) = 0$$

9. ***Ans. (b)***

Expansion of rod

= l α Δt = 0.5 × 12.5 × 10^{-6} × 20

= 1.25 × 10^{-4} m

Force will be induced due to

spring = 1.25 × 10^{-4} × 50 × 1000 = 6.25

$$\text{stress} = \frac{F}{A} = \frac{6.25}{\frac{\pi}{4} \times (10)^2} = 0.07945\text{MPa}$$

10. ***Ans. (b)***

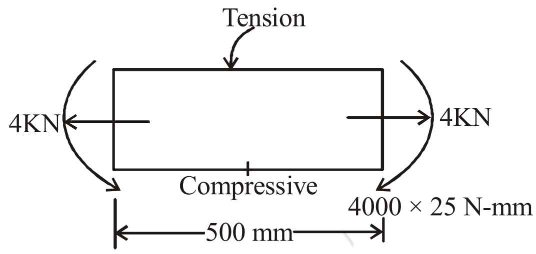
Thermla stress (σ) = αtE

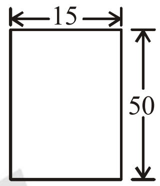
= 10^{-3} × 200 × 10^3 × 30

= 6000 N/mm^2 (compresive)

The stress induced is compressive is nature as a compressive force is exerted by the supports which prevents increase in length due to increase is temperature.

11. ***Ans. (c)***





Equivalent figure,

Bending stress

$$\sigma_b = \frac{M}{I}y = \frac{4000 \times 25}{\frac{1}{12} \times 15 \times (50)^3} \times 25 = 16\ \text{MPa}$$

$$\text{Tensile stress,}\quad \sigma_t = \frac{F}{A} = \frac{4000\text{N}}{15 \times 50\text{mm}^2}$$

Maximum compressive stress

= σ_b – σ_t = 16 – 5.33 = 10.67 MPa

12. ***Ans.(c)***

$$\frac{PL}{AE} + \frac{PL}{2AE} = \frac{1.5PL}{AE}$$

13. ***Ans.(b)***

Superposition principle is applicable for structural members with negligible deformation and the loads acting on the member are within elastic limit.

14. ***Ans.(b)***

Steel is less active due to temperature changes compared to copper, therefore steel is subjected to tension and copper is subjected to compression due to composite action,

15. ***Ans: (b)***

For any linear elastic member stiffness is reciprocal of flexibility.

16. ***Ans.(c)***

$$\frac{PL}{AE}+\frac{PL}{2AE}+\frac{PL}{AE}=\frac{2.5PL}{AE}$$

17. ***Ans. (c)***

Maximum stress in plate develops across rivet hole

$$P = 95 \times t \times 10cm$$
$$= \sigma \times t \times (10 - 5)cm$$

Max stress, $\sigma = 95\times\frac{10}{5}=190MPa$

18. ***Ans. (c)***

$\Sigma M_A = 0$

$$T_2(b)+T_1(a) = P(l) \quad ...(1)$$

$$\delta l_1(b) = \delta l_2(a)$$

$$\frac{T_1L}{AE}(b) = \frac{T_2L_a}{AE}$$

$$T_1 = \frac{a}{b}.T_2$$

Sub P_1 in equation (1)

$$T_2(b)+T_2\frac{(a^2)}{b} = P(L)$$

$$T_2\left(\frac{b^2+a^2}{b}\right) = PL$$

$$T_2 = \frac{PLb}{(a^2+b^2)}$$

Similarly $T_1 = \frac{PLa}{(a^2+b^2)}$

19. ***Ans. (b)***

20. ***Ans. (a)***

21. ***Ans. (c)***

A bar free to expand due to temperature has no stress

22. ***Ans. (a)***

Dimensional analysis gives (a) is wrong.

23. ***Ans. (a)***

Elongation in AC = length reduction in CB

$$\frac{R_A\times 1}{AE}=\frac{R_B\times 2}{AE}$$

and $R_A + R_B = 10$

24. ***Ans. (c)***

Thermal stress will develop only if expansion is restricted.

25. ***Ans. (d)***

$$\alpha E\Delta t = (12 \times 10^{-6}) \times (200 \times 10^3) \times (120 - 20)$$
$$= 240 \text{ MPa}$$

It will be compressive as elongation restricted.

26. ***Ans. (d)***

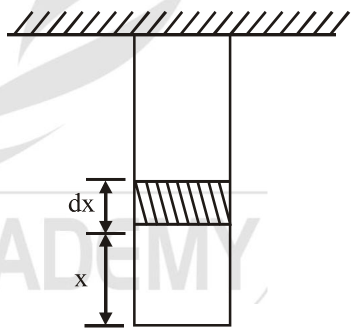
Elongation due to self weight

$$=\frac{WL}{2AE}=\frac{(\delta ALg)L}{2AE}$$

$$=\frac{\delta L^2 g}{2E}$$

27. ***Ans. (a)***

28. ***Ans. (b)***



The elongation of bar due to its own weight (W) is

$$\Delta = \frac{WL}{2AE}$$

Now $W = \rho AL$

$$\therefore \quad \Delta = \frac{\rho L^2}{2E}$$

29. Ans. (a)

$$\Delta_0 = \frac{4PL}{\pi E D_1 D_2}$$

Actual extension, $\Delta_0 = \frac{4PL}{\pi(2D^2)E} = \frac{2PL}{\pi D^2 E}$

The average diameter of bar

$$= \frac{2D + D}{2} = 1.5D$$

Approximate extension,

$$\Delta = \frac{4PL}{\pi \times (1.5D)^2 E} = \frac{4PL}{2.25\pi D^2 E}$$

$\therefore$ Error in calculation $= \left(1 - \frac{\Delta}{\Delta_0}\right) \times 100$

$$= \left(1 - \frac{2}{2.25}\right) \times 100 = 11.11\% \approx 10\%$$

30. Ans. (b)

Temperature Stress = E α ΔT

$$\frac{\text{Stress in bar A}}{\text{Stress in bar B}} = \left(\frac{E_A}{E_B}\right)\left(\frac{\alpha_A}{\alpha_B}\right) = 2 \times 2 = 4$$

31. Ans. (a)

32. Ans. (a)

A = Volumetric strain

$$\frac{\Delta V}{V} = \frac{(\sigma_x + \sigma_y + \sigma_z)}{E}(1 - 2\mu)$$

$$= \frac{p}{E}(1 - 2\mu)$$

B = Strain energy per unit volume

$$l = \frac{1}{2}\text{stress} \times \text{Strain} = \frac{p^2}{2E}$$

C = E = 3K (1 – 2μ)

$$\frac{E}{K} = 3(1 - 2\mu),\ E = 2G(1 + \mu)$$

33. Ans. (b)

The area of bar will become 4 times, and the volume as well as weight will increase 8 times. So increase in elongation

$\left(\Delta = \frac{WL}{2EA}\right)$ will be $\frac{8 \times 2}{4}$ = 4 times

34. Ans. (a)

If the material is homogeneous & isotropic, magnitude of deformation will be same if E & μ are same in all direction.

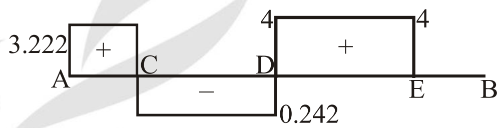
$$\varepsilon_x = \frac{\sigma_x}{E} - \frac{\mu\sigma_y}{E} - \frac{\mu\sigma_z}{E}$$

$$\varepsilon_x = \frac{-\sigma_x}{E} - \frac{\mu(-\sigma_y)}{E} - \frac{\mu(-\sigma_z)}{E}$$

Magnitude of ε_x in (i) as well as (ii) is same.

35. Ans. (a)

Section	Thrust (T)
AC	3.222
CD	3.222 – 3.464 = – 0.242
DE	– 0.242 + 4.242 = 4.0
EB	4 – 4 = 0



36. Ans. (d)

The elongation in the bar due to increase in temperature = LαΔT

Yield of support reduces strain in the bar by δ.

$$\therefore \quad \frac{\sigma L}{E} = L\alpha\Delta T = \delta$$

$$\sigma = E\left(\alpha\Delta T - \frac{\delta}{L}\right)$$

$$= 1 \times 10^6 \times \left(20 \times 10^{-6} \times 100 - \frac{0.01}{25}\right)$$

$= 1600$ kg/cm^2

37. ***Ans. (d)***

Since load of 1t is applied mid-way so force in both wires will be same and equals to 0.5 t.

$$\Delta_c = \frac{500\times 4}{1\times 10^6\times 4} = 5\times 10^{-4}\,\text{m}$$

$$\Delta_s = \frac{500\times 4}{2\times 10^6\times 2} = 5\times 10^{-4}\,\text{m}$$

$$\therefore \quad \frac{\Delta_c}{\Delta_s} = 1.0$$

38. ***Ans. (b)***

Since both the ends of the bar are unyielding. With increase in temperature, both bars will be in compression and the load will be transfered to the supports.

39. ***Ans. (c)***

$$\frac{\Delta_1}{\Delta_2} = \frac{L_1}{L_2}\times\frac{A_2}{A_1}$$

Since $L_1 = L_2$ and $A_1 = 2A_2$

$$\therefore \quad \frac{\Delta_1}{\Delta_2} = 1\times\frac{1}{2} = \frac{1}{2}$$

40. ***Ans. (d)***

The actual extension is more than approximate extension based on average diameter.

41. ***Ans. (d)***

$$\text{Total elongation} = \frac{4PL}{\pi E}\left(\frac{1}{d_1^2}+\frac{1}{d_2^2}+\frac{1}{d_3^2}\right)$$

$$= \frac{4\times 10\times 100}{\pi E\times 100}\left[\frac{1}{16}+\frac{1}{25}+\frac{1}{36}\right]\text{mm}$$

$$= \frac{40}{\pi E}\left(\frac{1}{16}+\frac{1}{25}+\frac{1}{36}\right)\text{mm}$$

42. ***Ans. (a)***

$$e_x = \frac{1}{E}\left(p_x+\mu p_y-\mu p_z\right)$$

43. ***Ans. (c)***

We knowthat temperature stresses do not depend upon properties of cross section like length and area. They only depends upon properties of the material.

$$\therefore \quad \sigma = \alpha E\Delta T$$

$= 12.5\times 10^{-6}\times 200\times 10^3\times 30 = 75\ \text{MN/m}^2$

❍❍❍