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CONTENTS

UNIT-I

STRENGTH OF MATERIALS

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21. 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

22. 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

23. 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

24. For a given stress, the ratio of moment of resistance of a square beam with its size horizontal, as compared to when the diagonal is horizontal, is

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

(c) 1.2 (d) 1.5

25. The intensity of bending stress in the x-section at any distance y from the N.A. is proportional to

(a) $\frac{1}{y^2}$ (b) y

(c) y^2 (d) $\sqrt{y}$

26. 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

27. A rigid beam of negligible weight is supported in a horizontal position by two rods steel and aluminium, 2 m and 1 m long having values of cross-sectional areas 1 cm^2 and 2 cm^2 and E = 2×10^6 kg/cm^2 and E = 1×10^6 kg/cm^2 respectively. What is the guide line for placing a load P on beam such that it remains horizontal

(a) Forces on both rods should be equal

(b) Force on aluminium rods should be twice the force on steel

(c) Force on steel rod should be twice the force on aluminium

(d) Unpredictable

28. Two beams have same width but one beam has double the depth of the other. The elastic strength of double depth beam compared to the other beam will be

(a) Double (b) Four times

(c) Eight times (d) Same

29. A beam is of rectangular section. The distribution of shearing stress across a section is

(a) Parabolic (b) Rectangular

(c) Triangular (d) None of the above

30. If the areas of cross-sections of square and circular beams are same and both are subjected to equal bending moment, then

(a) Circular beam is more economical

(b) Square beam is more economical

(c) Both the beams are equally strong

(d) Both the beams are equally economical

31. If a beam is cut in halves horizontally and the two halves tied side by side, then the later in comparison to the original beam will carry

(a) Same load (b) Double load

(c) Half load (d) One fourth load

32. The bending equation is

(a) $\frac{I}{M}=\frac{\sigma}{y}=\frac{E}{R}$ (b) $\frac{M}{I}=\frac{\sigma^2}{y}=\frac{E^2}{R^2}$

(c) $\frac{M}{I}=\frac{\sigma}{y}=\frac{E}{R}$ (d) $\frac{M^2}{I}=\frac{\sigma^2}{y}=\frac{E^2}{R}$

[NTPC-DIP - Trainee]

33. Circular beams of uniform strength can be made by varying diameter in such a way that

(a) $\frac{M}{Z}$ is constant (b) $\frac{\sigma}{y}$ is constant

(c) $\frac{E}{R}$ is constant (d) $\frac{M}{R}$ is constant

[NTPC-DIP - Trainee]

34. The well known bending formula is

(a) $\frac{M}{I}=\frac{E}{R}$ (b) $\frac{M}{R}=\frac{E}{I}$

(c) $\frac{M}{I}=\frac{y}{\sigma}$ (d) $\frac{M}{R}=\frac{y}{\sigma}$

[NTPC-DIP - Trainee]

35. A solid shaft of uniform diameter 'D' is subjected to equal amount of bending and twisting moment 'M'. What is the maximum shear stress developed in the shaft?

(a) $\frac{16\sqrt{2}M}{\pi D^3}$ (b) $\frac{16M}{\sqrt{2}\pi D^3}$

(c) $\frac{32\sqrt{2}M}{\pi D^3}$ (d) $\frac{16}{\pi D^3}$

[NTPC-DIP - Trainee]

36. Two simply supported beams of equal lengths, cross-sectional areas, and section moduli, are subjected to the same concentrated load at its mid-length. One beam is made of steel and other is made Aluminium. The maximum bending stress induced will be in

(a) Steel beam

(b) Aluminium beam

(c) Both beams of equal magnitude

(d) The beams according to their Elastic Moduli magnitude

37. Which one of the following will result into a constant strength beam?

(a) The bending moment at every section of the beam is constant

(b) Shear force at every section is same

(c) The beam is of uniform section over its whole length

(d) The ratio of bending moment to the section modulus for every section along the length is same

38. The bending moment at a section tends to bend or deflect the beam and the internal stresses resist bending. The resistance offered by the internal stresses to the bending is called

(a) Compressive stress

(b) Shear stress

(c) Bending stress

(d) Elastic modulus

39. The rectangular beam A has a length *l*, width b and depth d. Another beam B has the same length and width but depth is double that of A.The elastic strength of beam B will be _____ as compared to beam A.

(a) same (b) double

(c) one-fourth (d) four times

40. When a shaft of diameter D is subjected to a twisting moment T and bending moment M, then equivalent bending moment M_e is given by

(a) $\sqrt{M^2+T^2}$

(b) $\sqrt{M^2-T^2}$

(c) $\frac{1}{2}(M+\sqrt{M^2+T^2})$

(d) $\frac{1}{2}(M-\sqrt{M^2+T^2})$

41. Principal planes are the planes, on which the resultant stress is the

(a) Shear stress (b) Normal stress

(c) Tangential stress (d) None of these

[NTPC-DIP - ME]

42. Ties are load carrying members which have many

(a) Torsional loads

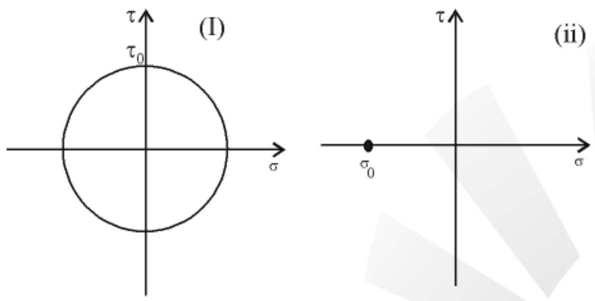
(b) Axial compressive loads

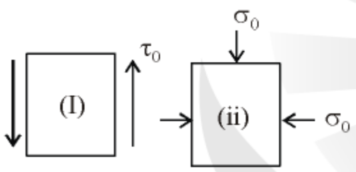
(c) Axial tension loads

(d) Transverse loads

[NTPC-DIP - ME]

43. Select the appropriate pair of elements with the same state of stress as given by the following Mohr's circles.



(a)


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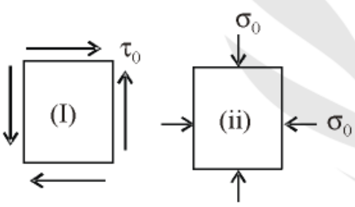

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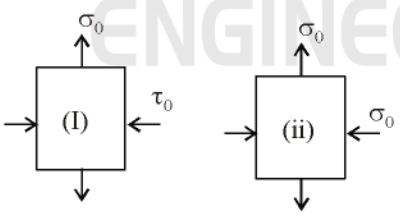

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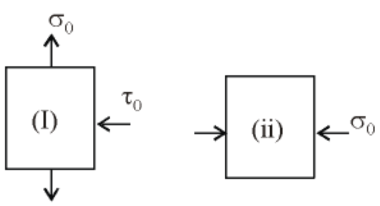
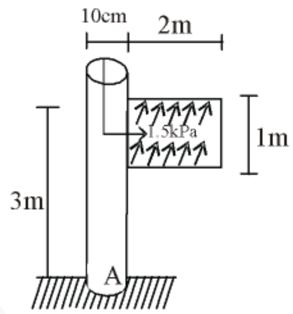


44. A sign supported by a post of circular cross-section is subjected to a uniform wind load that acts normal to its plane as shown in the figure.What are the magnitudes of the normal and shear components of stress(σ_{xx},τ_{xy}) at A? Assume the moment of inerita *(I)* = 5×10^{-6} m^4



(a) σ_{xx} = 90 MPa, τ_{xy} = 30 MPa

(b) σ_{xx} = 180 MPa, τ_{xy} = 30 MPa

(c) σ_{xx} = 90 MPa, τ_{xy} = 15 MPa

(d) σ_{xx} = 180 MPa, τ_{xy} = 15 MPa

45. The distance of centroid of a wire bent in the shape of the quarter circle of radius R from its centre is

(a) $2R/\pi$ (b) $2\sqrt{2}\,R/\pi$

(c) $4R/3\pi$ (d) $3R/8$

[QP-Mechanical - I]

46. The cross section area of a hollow cylinder has an internal diameter of 50 mm and a thickness of 5 mm. Moment of inertia of the cross-section about its centroidal axis is

(a) 2.848×10^{5} mm^4

(b) 3.294×10^{-5} mm^4

(c) 1.424×10^{5} mm^4

(d) 3.294×10^{5} mm^4

[QP-Mechanical - I]

47. A circular log of timber has diamter D. Find the dimension of the strongest rectangular section which can be cut from it.

(a) $D/\sqrt{3}$ wide and $\sqrt{(2/3)}$ D deep

(b) $D^2/\sqrt{3}$ wide and $\sqrt{(2/3)}$ D deep

(c) $D/\sqrt{2}$ wide and $\sqrt{(2/3)}$ D deep

(d) $D/\sqrt{3}$ wide and $\sqrt{(1/3)}$ D deep

[QP-Mechanical - I]

48. Moment of Inertia of an elliptical area about the major axis is.

(a) $\pi xy^3/4$ (b) $\pi xy^3/3$

(c) $\pi x^2y^3/4$ (d) πx^2y^3

[QP-Mechanical - I]

49. A rectangular beam, 300 mm deep, is simply supported over a span of 4m. Determine the uniformally distributed load per meter, which the beam can carry, if the bending stress does not exeed 120 N/mm^2. Take moment of inertia of the beam = 8×10^6 mm^4.

(a) 3.2 N/mm (b) 1.2 N/mm

(c) 4.2 N/mm (d) 4.5 N/mm

[QP-Mechanical - I]

50. Bending stress in a beam at a distance of 15 cm from neutral axis is 50 MPa. Determine the magnitude of bending stress at a distance of 10 cm from neutral axis.

(a) 50 MPa (b) 30.43 MPa

(c) 33.33 MPa (d) 75 MPa

[QP-Mechanical - I]

51. The ratio of moment of inertia of a cross section to the distance of extreme fibers from the neutral axis is known as

(a) Elastic modulus (b) Bulk modulus

(c) Shear modulus (d) Section modulus

[QP-Mechanical - I]

52. In the case of a curved beam subjected to pure bending, which of the following is true?

(a) Neutral axis coincides with the centroidal axis.

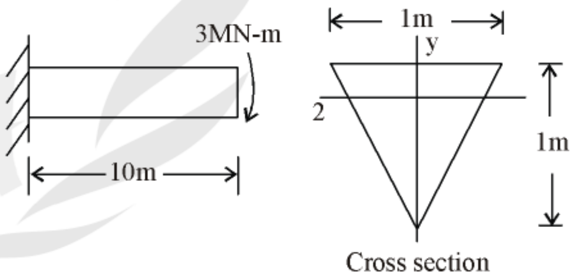
(b) Neutral axis lies between the centroidal axis and the centre of curvature.

(c) Location of neutral axis depends upon the magnitude of bending moment

(d) There is no neutral axis.

[DRDO - 2008]

53. A cantilever beam has the cross-section of an isosceles triangle and is loaded as shown in figure. If the moment of inertia of the cross-section $I_{xx} = \frac{1}{36} m^4$, then the maximum tensile bending stress is



(a) 1/16 MPa (b) 72 MPa

(c) 36 MPa (d) 1/36 MPa

[DRDO - 2008]

54. If a rectangular beam is loaded transversely, the maximum compressive stress will be developed on the :

(a) Bottom layer

(b) Top layer

(c) Every cross-section

(d) Neutral axis

[NMRC-JE-ME - 2017]

55. A machine component has a cross section area of 100 mm^2 and section modulus of 5×10^3 mm^3. It is subjected to an eccentric axial tensile load of 10 kN with an eccentricity of 10 mm. What will be the maximum and minimum stresses developed in the member?

(a) 120 MPa (tensile) and 80 MPa (tensile)

(b) 120 MPa (tensile) and 80 MPa (compressive)

(c) 80 MPa (tensile) and 80 MPa (compressive)

(d) None of these

56. Two beams of equal cross sectional area are subjected to same bending moment. The beam A is of solid circular section and the beam B is of square cross section. Which of these will be stronger in bending?

(a) Beam A

(b) Beam B

(c) Both will be equally strong

(d) Relative strength will depend upon point of application of load

57. In a beam of I cross-section, subjected to a transverse load, the maximum shear stress is developed

(a) At the centre of the web

(b) At the top edge of the top flange

(c) At the bottom edge of the top flange

(d) At one third distance along the web

[MPE - 2014]

58. In theory of simple bending of beams, which one of the following assumptions is incorrect?

(a) Elastic modulus in tension and compression are same for the beam materials

(b) Plane sections remain plane before and after bending

(c) Beam is initially straight

(d) Beam material should not be brittle

59. A beam of Z-section is called a

(a) Doubly symmetric section beam

(b) Singly symmetric section beam

(c) A symmetric section beam

(d) None of the above

60. The section modulus of rectangular section is

(a) $\frac{bd^3}{12}$ (b) $\frac{bd^2}{12}$

(c) $\frac{bd^2}{6}$ (d) $\frac{bd^3}{6}$

[MEPE - 2013]

61. The section modulus of hollow circular section is

(a) $\frac{\pi}{16D}(D^4 - d^4)$ (b) $\frac{\pi}{32D}(D^4 - d^4)$

(c) $\frac{\pi}{32D}(D^3 - d^3)$ (d) $\frac{\pi}{16D}(D^3 - d^3)$

[MEPE - 2013]

62. The residual stresses are generally called as..........

(a) Elastic stress (b) Ultimate stress

(c) Plastic stress (d) Yield stress

63. For a load of 3000N if the stress is 100 N/m^2 the diameter of rod will.............

(a) $\sqrt{\left(\frac{\pi}{120}\right)}m$ (b) $\sqrt{\left(\frac{120}{\pi}\right)}m$

(c) $\frac{\pi}{120}m$ (d) $\frac{120}{\pi}m$

64. For steel, the ultimate strength in shear as compared to in tension is nearly

(a) Same (b) Half

(c) One-third (d) Two-third

65. σ_1, σ_2, σ_3 are thre mutually perpendicular principal stresses with ε_1, ε_2, and ε_3 being the strains produced in the respective direction of the stress, the strain energy stored per unit volume in a cube is:

(a) $\sigma_1\varepsilon_1+\sigma_2\varepsilon_2+\sigma_3\varepsilon_3$

(b) $1/2(\sigma_1\varepsilon_1+\sigma_2\varepsilon_2+\sigma_3\varepsilon_3)$

(c) $1/2(\sigma_1\varepsilon_1^2+\sigma_2\varepsilon_2^2+\sigma_3\varepsilon_3^2)$

(d) $1/2(\sigma_1^2\varepsilon_1^2+\sigma_2^2\varepsilon_2^2+\sigma_3^2\varepsilon_3^2)$

22. ***Ans. (c)***

23. ***Ans. (c)***

24. ***Ans. (b)***

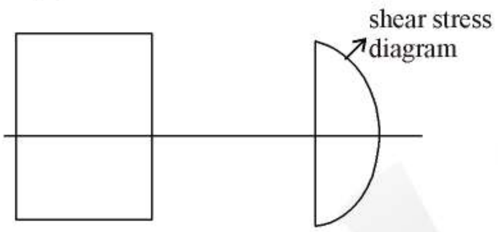
25. ***Ans. (b)***

26. ***Ans. (a)***

27. ***Ans. (b)***

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

29. ***Ans. (a)***



30. ***Ans. (b)***

31. ***Ans. (c)***

32. ***Ans. (c)***

33. ***Ans. (a)***

Beam of uniform shear stress means – stress is constant

$$M = \sigma z$$

$$\frac{M}{Z} = \sigma(\text{Constant})$$

$$\frac{M}{Z} = \text{Constant}$$

34. ***Ans. (a)***

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

35. ***Ans. (a)***

$$T = M$$

$$\text{equivalent torque}(T_e) = \sqrt{M^2 + T^2}$$

$$= \sqrt{2T^2} = T\sqrt{2}$$

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

$$= \frac{16\sqrt{2}T}{\pi d^3} = \frac{16\sqrt{2}M}{\pi d^3}$$

36. ***Ans. (c)***

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

$$M = \sigma_b \times Z$$

Same moment, same z

So, σ_b (bending stress is also same)

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

38. ***Ans (c)***

39. ***Ans (d)***

Strength higher, whose section modular is higher

l, b, d

$$z = \frac{I}{y}$$

$$z_1 = \frac{bd^3}{12} \times \frac{2}{d}$$

$$z_1 = \frac{bd^2}{6}$$

l, w, 2d

$$z_2 = \frac{b(2d)^2}{6}$$

$$z_2 = 4\left(\frac{b\,d^2}{6}\right)$$

$$z_2 = 4\ z_1$$

40. ***Ans (c)***

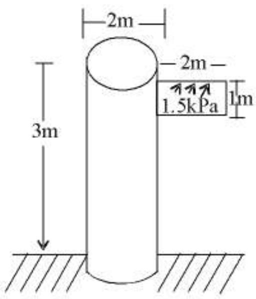
41. ***Ans (b)***

42. ***Ans (c)***

Tie beam carry - Axial compressive loads

43. ***Ans. (b)***

44. ***Ans. (c)***



$I = 5\times10^{-6}\ m^4$

Normal force $= P \times A$

$= 1.5 \times 10^3 \times 2 = 3000$ N

(1) Bending moment (M) $= \sigma z$

$3000 \times 3 = \sigma z$

$$z = \frac{5\times10^{-6}}{.05}$$

$z = 10^{-4}$

$9000 = \sigma \times 10^{-4}$

$90\ MPa = \sigma$

$T_{orque} = F \times r_{\perp}$

$\Rightarrow \quad 3000 \times 1$

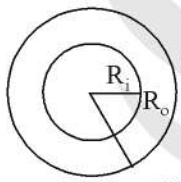
$= 3000$ N

$$\frac{16\times3000}{\pi(0.1)^3} = \sigma_s$$

$\sigma_s = 15.27$ MPa.

45. ***Ans. (a)***

46. ***Ans. (d)***



R_o-R_i = thickness

$d_i = 50$ mm

$r_i = 25$ mm

$t = 5$ mm

$d_o = d_i + 2t$

$d_o = 50 + 10 = 60$ mm

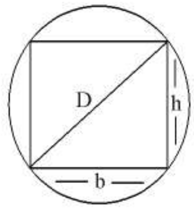
$$I = \frac{\pi}{64}[d_o^4 - d_i^4]$$

$$= \frac{\pi}{64}[60^4 - 50^4]$$

$= 329376.35\ mm^4$

$= 3.293 \times 10^5\ mm^4$

47. ***Ans. (a)***



D = dia of circular log

$D^2 = h^2 + b^2$ ...(i)

$$Z_{rectangular} = \frac{bh^2}{6} = \frac{b}{6}[D^2 - b^2]$$

For maximum Z, differentiate Z with respect to (b)

$$\frac{d}{db}(z) = \frac{1}{6}[bD^2 - b^3]$$

$= D^2 - 3b^2$

$D^2 - 3b^2 = 0$

$$\frac{D}{\sqrt{3}} = b$$

Putting in equation (i)

$$D^2 = h^2 + \frac{D^2}{3}$$

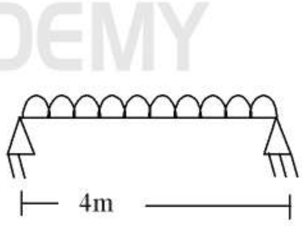
$$D^2 - \frac{D^2}{3} = h^2$$

$$\frac{2D^2}{3} = h^2$$

$$\sqrt{\frac{2}{3}}D = h$$

48. ***Ans. (a)***

49. ***Ans. (a)***



$\sigma_b = 120 \times 10^6$(max.)

$I = 8 \times 10^6 \times 10^{-12}$

$= 8 \times 10^{-6}\ m^4$

Max. B.M in UDL $= \dfrac{wl^2}{8}$

$M = \sigma \times z$

$$z = \frac{I}{y} = \frac{8\times10^{-6}}{.15}$$

$$= 53.33 \times 10^{-6}$$

$$\frac{wl^2}{8} = 120 \times 10^6 \times 53.33 \times 10^{-6}$$

$$\frac{wl^2}{8} = 6400$$

$$\frac{w\times(16)}{8} = 6400$$

$$w = 3200 \text{ N/m or } 3.2 \text{ N/mm}$$

50. ***Ans. (c)***

$$\sigma_b \propto y$$

$$\frac{50}{15} = \frac{\sigma}{10}$$

$$\sigma = \frac{100}{3} = 33.33 \text{ MPa}$$

51. ***Ans. (d)***

52. ***Ans. (a)***

53. ***Ans. (c)***

$$\sigma_b = \frac{M\times Y}{I_{xx}}$$

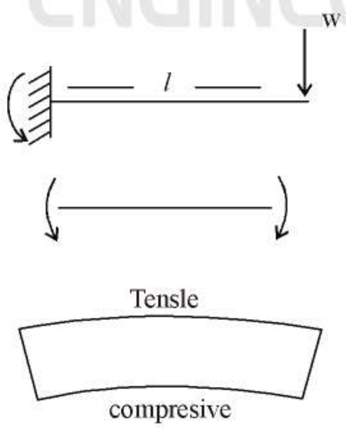
$$Y = \frac{1}{3}$$

$$M = 3\text{MN-m}$$

$$I_{xx} = \frac{1}{36}\text{m}^4$$

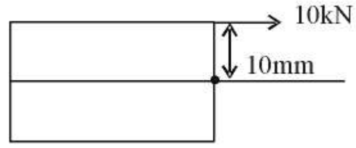
$$\sigma_b = 36 \text{ MPa}$$

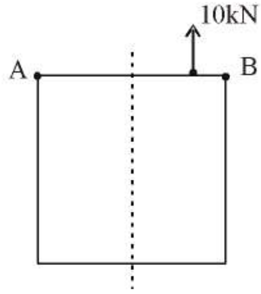
54. ***Ans. (a)***



Bottom layer subjected to compressive stress.

55. ***Ans. (a)***





Given,

$$Z = 5\times10^3 \text{ mm}^3$$

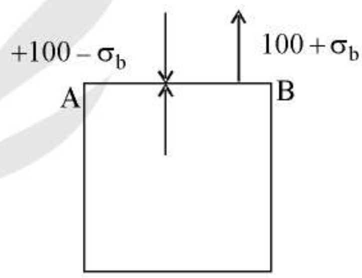
$$\text{eccentricity} = 10 \text{ mm}$$

$$\text{Area} = 100 \text{ mm}^2$$

Stress at A & B due to direct load $= \dfrac{10\times10^3}{100\times10^{-6}}$

$$= 100 \text{ MPa}$$

As load is eccentricity,Bending will also occur.



Anticlockwise moment

$$= 10\times10^3\times\frac{10}{1000} \quad [F \times r]$$

$$= 100 \text{ Nm}$$

$$\sigma_b = \frac{M}{Z} = \frac{100}{5\times10^{-6}}$$

$$= 20 \text{ MPa}$$

At $\quad A = 100 - 20 = 80$ MPa

$\quad B = 100 + 20 = 120$ MPa

56. ***Ans. (b)***

$$\frac{\pi}{4}d^2 = b^2$$

Equal cross-sectional Area

$$Z_{circle} = \frac{I}{y} = \frac{\pi d^4 \times 2}{64 \times d}$$

$$Z_{circle} = \frac{\pi d^3}{32}$$

$$d^2 = \frac{4b^2}{\pi}$$

$$d = \frac{2b}{\sqrt{\pi}} = 1.12\ b$$

$$Z_{circle} = \frac{\pi}{32}(1.12b)^3$$

$$= 0.137\ b^3$$

$$M = \sigma \times z$$

Same Bending moment

$$\sigma \propto \frac{1}{z}$$

$$Z_{square} = \frac{b^4 \times 2}{12 \times b} = \frac{b^3}{6}$$

$$Z_{square} = 0.16\ b^3$$

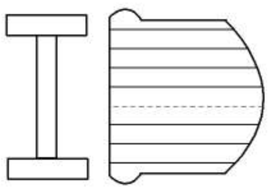
Whose Z is more, less stress will be generated

So, $Z_{square} > Z_{circle}$

$\sigma_{square} < \sigma_{circle}$

So, square is safe.

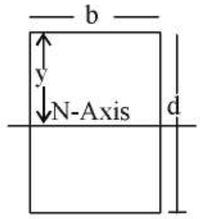
57. ***Ans. (a)***



58. ***Ans. (d)***

59. ***Ans. (a)***

60. ***Ans. (c)***



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

$$I_{rectangular} = \frac{bd^3}{12}$$

$$y = \frac{d}{2}$$

$$Z = \frac{bd^3}{12 \times d} \times 2$$

$$Z = \frac{bd^2}{6}$$

61. ***Ans. (b)***

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

$$I_{hollow} = \frac{\pi}{64}[D_o^4 - D_i^4]$$

$$y = \frac{D_o}{2}$$

$$I = \frac{\pi}{64}[D_o^4 - D_i^4]$$

$$y = \frac{D_o}{2}$$

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

$$= \frac{\pi}{64 \times D_o}[D_o^4 - D_i^4]$$

$$Z = \frac{\pi}{32 D_o}[D_o^4 - D_i^4]$$

UNIT-IV

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DYANAMICS ANALYSIS OF SLIDER CRANK MECHANISM

CHAPTER 2

OBJECTIVE QUESTIONS

1. Velocity of piston at inner dead centre is

(a) Maximum (b) Minimum

(c) Zero (d) Unpredictable

2. Reciprocating motion of Piston is converted into Rotary by

(a) Piston rod

(b) Crank shaft

(c) Intermediate gear

(d) Connecting rod

3. For simple harmonic motion the acceleration is proportional to

(a) Rate of change of angular velocity

(b) Distance from centre

(c) Linear velocity

(d) Displacement from mean position

4. The direction of Inertia force is

(a) Opposite to the direction of accelerating force

(b) Direction perpendicular to accelerating force

(c) Along the direction of accelerating force

(d) In any direction

5. In case of a reciprocating engine, the angular acceleration of the connecting rod is approximately given by

(a) $\frac{\omega^2 \cos^2\theta}{n}$ (b) $\frac{\omega^2 \sin\theta}{n}$

(c) $\frac{\omega^2 \cos 2\theta}{n}$ (d) $\frac{\omega^2 \sin 2\theta}{n}$

6. Acceleration of piston in reciprocating motion is expressed as

(a) $\omega^2 r\left[\cos 2\theta + \frac{\cos\theta}{n}\right]$

(b) $\omega^2 r\left[\cos\theta + \frac{\cos 2\theta}{n}\right]$

(c) $\omega^2 r\left[\cos\theta + \frac{\sin\theta}{n}\right]$

(d) $\omega^2 r\left[\sin\theta + \frac{\sin 2\theta}{n}\right]$

7. How many instantaneous centres of rotation are present in a slider crank mechanism?

(a) 3 (b) 4

(c) 6 (d) 8

[NTPC-DIP - Trainee]

8. Length of crank of a slotted lever quick return mechanism is 150 mm while the distance between centre of crank rotation and slotted lever is 300 mm. What is the ratio of time of cutting to time of return of this mechanism?

(a) 4 (b) 3

(c) 2 (d) 1

[NTPC-DIP Trainee]

9. In a slotted level return mechanism, the crank length is 20 cm while the distance between centres of crank and slotted lever rotation is 40 cm. What is the ratio of cutting stroke time to return stroke time?

(a) 2 (b) 3

(c) 4 (d) 5

[NTPC-DIP - Trainee]

10. In a slider crank mechanism, piston velocity becomes maximum for the following configuration when crank is

(a) At inner dead centre

(b) At outer dead centre

(c) Perpendicular to line of stroke

(d) Perpendicular to connecting rod

[NTPC-DIP - Trainee]

11. The number of instantaneous centres for a six link mechanism in planer motion is

(a) 30 (b) 15

(c) < 6 (d) > 6

[NTPC-DIP - Trainee]

12. In a slotted lever quick return mechanism the number of instantaneous centres of rotation is

(a) 6 (b) 10

(c) 12 (d) 15

[NTPC-DIP - Trainee]

13. The acceleration of the piston in a reciprocating steam engine, neglecting the weight of the connecting rod is given by

ω = Angular velocity of the crank

r = Radius of the crank

θ = Angle turned by the crank from inner dead centre

n = Ratio of length of connecting rod to crank radius

(a) $\omega r\left(\cos\theta+\frac{\cos 2\theta}{n}\right)$ (b) $\omega^2 r\left(\cos\theta+\frac{\cos 2\theta}{n}\right)$

(c) $\omega r\left(\sin\theta+\frac{\sin 2\theta}{n}\right)$ (d) $\omega^2 r\left(\sin\theta+\frac{\sin 2\theta}{n}\right)$

[MEPE - 2013]

14. The instantaneous center of rotation of a rigid thin disc rolling on a plane rigid surface is located at

(a) The centre of the disc

(b) The point of contact

(c) An infinite distance on the plane surface

(d) The point on the circumference situated vertically opposite to the contact point

[TSPSC - AE]

15. When two links are connected by a pin joint, their instantaneous centre lies

(a) On their point of contact

(b) At the centre of curvature

(c) At the centre of circle

(d) None of these

16. The instantaneous center of rotation is a point of

(a) Zero Angular velocity

(b) Zero Displacement

(c) Zero Acceleration and Displacement

(d) Pure Rotation at any instant

[QP-Mechanical - I]

17. Klein's diagram is used to find

(a) Angular velocity of various parts

(b) Velocity of various parts

(c) Acceleration of various parts

(d) Velocity and acceleration of various parts

[QP-Mechanical - I]

18. Consider the following geometrical figures

1. Cycloid
2. Ellipse
3. Circle
4. Parabola

Which of these accurately describe the path traced by a point on a link connecting double slider crank chain

(a) 1 (b) 1 and 2

(c) 2 (d) 1, 3 and 4

[QP-Mechanical - I]

19. In elliptical trammels

(a) All four pairs are sliding

(b) All four pair are turning

(c) Two pairs are turning and other two sliding

(d) One pair turning and three pair sliding

[QP-Mechanical - I]

20. The maximum force which acts on the connecting rod is

(a) Force due to gas pressure

(b) Force due to inertia of piston

(c) Force due to friction of connecting rod

(d) Force due to crank pin

[MEPE - 2013]

21. The direction of linear velocity of any point on a rotating link with respect to another point on the same link is

(a) Perpendicular to the link joining the points

(b) At 45° to the link joining the points

(c) Parallel to the link joining the points

(d) At 90° to the link joining the points

[AEM]

22. In a slider-crank mechanism, the crank is rotating with an angular velocity of 20 rad/s in counterclockwise direction. At the instant when the crank is perpendicular to the direction of the piston movement, velocity of the piston is 2 m/s. Radius of the crank is

(a) 100 cm (b) 10 cm

(c) 1 cm (d) 0.1 cm

[DRDO - 2008]

23. A slider crank mechanism with crank radius 60 mm is perpendicular to connecting rod having length 240 mm. The crank is rotating with uniform angular speed of 10 rad/s, counter clockwise. For the given configuration, the speed of slider is ___ m/s.

(a) 618 (b) 0.618

(c) 6.18 (d) 61.8

[RPSC AEN - 2013]

24. In a slider-crank mechanism, the piston velocity is maximum, when :

(a) Crank is perpendicular to line of stroke

(b) Crank and connecting rod are collinear

(c) Crank is perpendicular to connecting rod

(d) None of the above

25. When the angle of inclination of the crank with inner dead centre of a reciprocating engine is 45°, then

(a) Primary force is maximum

(b) Secondary force is maximum

(c) Primary force is zero

(d) Secondary force is zero

26. If the ratio of the length of connecting rod and the crank radius increases

(a) Primary unbalanced forces increases

(b) Primary unbalanced forces decreases

(c) Secondary unbalanced forces increases

(d) Secondary unbalanced forces decreases

[AEM - 2017]

27. In a locomotive, the ratio of the connecting rod length to the crank radius is kept very large in order to

(a) Minimise the effect of primary forces

(b) Minimise the effect of secondary forces

(c) Have perfect balancing

(d) Start the locomotive quickly

[CEMPM - 2018]

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ANSWERS AND EXPLANATIONS

1. *Ans. (c)*

2. *Ans. (d)*

3. *Ans. (d)*

4. *Ans. (a)*

5. *Ans. (b)*

6. *Ans. (b)*

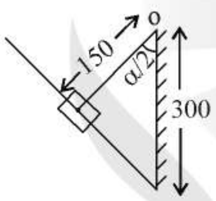
7 *Ans. (c)*

Crank slider has 4 links.

$$\text{No. of I-Centre} = \frac{n(n-1)}{2}$$

$$= \frac{4\times 3}{2} = 6$$

8 *Ans. (c)*



$$\cos\frac{\alpha}{2} = \frac{150}{300}$$

$$\frac{\alpha}{2} = \cos^{-1}\left(\frac{1}{2}\right)$$

$$\frac{\alpha}{2} = 60°$$

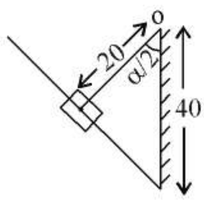
$$\alpha = 120°$$

$$\beta = 240°$$

$$QRR = \frac{\beta}{\alpha}$$

$$= \frac{240}{120} = 2$$

9. *Ans. (a)*



$$\cos\left(\frac{\alpha}{2}\right) = \frac{20}{40}$$

$$\cos\left(\frac{\alpha}{2}\right) = \frac{1}{2}$$

$$\frac{\alpha}{2} = \cos^{-1}\left(\frac{1}{2}\right)$$

$$\alpha = 120°$$

$$\beta = 240°$$

$$QRR = \frac{240}{120}$$

$$= 2$$

10. *Ans. (d)*

$$V_{\text{Piston}} = r\omega\left[\sin\theta + \frac{\sin 2\theta}{2n}\right]$$

11. *Ans. (b)*

$$\text{No. of I-Centre} = \frac{n(n-1)}{2}$$

$$= \frac{6(6-1)}{2}$$

$$= 15$$

12. *Ans. (a)*

Crank and slotted lever is inversion of single slider crank mechanism which has 4 links (n = 4)

$$\text{No. of I-Centre} = \frac{n(n-1)}{2}$$

$$= \frac{4(4-1)}{2} = 6$$

13. *Ans. (b)*

$$a \Rightarrow \omega^2 r\left[\cos\theta + \frac{\cos 2\theta}{n}\right]$$

14. *Ans. (b)*

15. *Ans. (a)*

16. *Ans. (d)*

17. *Ans. (d)*

Velocity - Triangle

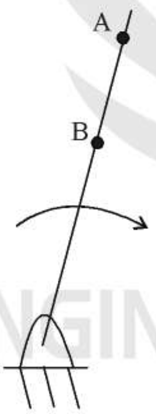
Acceleration - Quadilatral

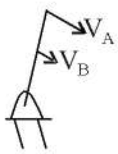
18. *Ans. (c)*

19. *Ans. (c)*

20. *Ans. (a)*

21. *Ans. (a)*



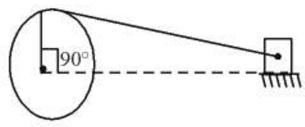


Relative velocity will only come when link is rotating

$V_A = r_A \times \omega$; $V_B = r_B \times \omega$

Velocity is perpendicular to link [Always]

22. *Ans. (b)*



$$V = r\omega\left[\sin\theta + \frac{\sin 2\theta}{2n}\right]$$

$$\theta = 90°$$

$$V = r\omega$$

$$2 = r \times 20$$

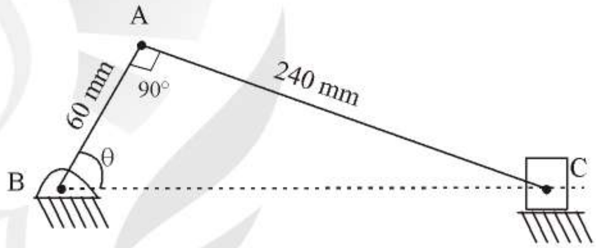
$$r = \frac{1}{10} = 0.1 \text{ m} = 10 \text{ cm}$$

23. *Ans. (b)*

$r = .06$ m

$l = .24$ m

$\omega = 10$ rad/sec



$$n = \frac{240}{60} = 4$$

$$V_{slider} = r\omega\left[\sin\theta + \frac{\sin 2\theta}{2n}\right]$$

$$\text{Cos}\theta = \frac{60}{247.38}$$

$$\theta = 75.96$$

$$= .06 \times 10\left[\sin 75.96 + \frac{\sin 151.92}{2 \times 4}\right]$$

$$= 0.6[.9701 + .0588]$$

$$= 0.61 \text{ m/s}$$

24. *Ans. (c)*

$$V = r\omega\left[\sin\theta + \frac{\sin 2\theta}{n}\right]$$

25. *Ans. (d)*

$$F_{un} = mr\omega^2\left[\cos\theta + \frac{\cos 2\theta}{n}\right]$$

$$= mr\omega^2\cos\theta + \frac{mr\omega^2\cos 2\theta}{n}$$

if $\theta \Rightarrow 45°$

$\cos 2\theta = \cos 90° = 0$

So, secondary force is 0.

26. *Ans. (d)*

$$F_{un} = mr\omega^2\cos\theta + \frac{mr\omega^2\cos 2\theta}{n}$$

As $n = \frac{l}{r}$

27. *Ans. (b)*

$$F_{un} = mr\omega^2\cos\theta + \frac{mr\omega^2\cos 2\theta}{n}$$

As $n \uparrow F_{secondary} \downarrow$

❑❑❑