Shaikh sir’s
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:::subject:::
Strength of material

Question bank
on
Numerical problems

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TYPE 1. PROBLEMS ON STRESSES AND STRAIN.

1. A steel rod 500mm long and 20mm×10mm in cross-section is subjected to axial pull of 300 KN.If modulus of elasticity is 2×105 N/mm2 .Calculate the elongation of the rod.

(Ans: 3.75mm)

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2. A hollow cylinder 2 m long has an outside diameter of 50mm and inside diameter of 30mm. If the cylinder is carrying a load of 25 KN. FInd the stress in cylinder , also find deformation of the cylinder E=100 Gpa.

(Ans: Stress=19.9 N/mm2 , Deformation=)

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3. A load of 5KN is to be raised with the help of a steel wire. FInd the minimum diameter of wire if stress is not to exceed 100 MPa.

(Ans: d=7.98mm)

4.In an experiment a steel specimen of 13mm diameter was found to elongate 0.2mm in a 200 mm gauge length when it was subjected to a force of 26.8 KN. If specimen was tested within elastic range, Calculate Young's modulus for the steel specimen.

(Ans: E=201.9×103 N/mm2)

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5. A hollow cast iron column has internal diameter 200mm. What should be external diameter of the column, so that it could carry a load of 1.6MN without the stress exceeding 90 MPa.

(Ans: d=250mm)

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6. A brass rod 1.5 m long and 20mm diameter was found to deform by 1.9mm under tensile load of 40KN. Calculate the modulus of elasticity.

(Ans:Modulus of elasticity=100 .51$\times 10^3$ N/mm2)

7.A bar 500mm long and 22mm in diameter is elongated by 1.2mm under the effect of axial pull of 105 KN. Calculate intensity of stress,strain and modulus of elasticity..

(Ans:stress=276.22 N/mm2 ,strain=2.4 e-3, E=115.09 e3)

8.A mild steel flat 75mm wide, 150mm thickness and 1.5 m long is subjected to pull of 45 KN. If elongation of flat is 0.6380mm. Find the young's modulus

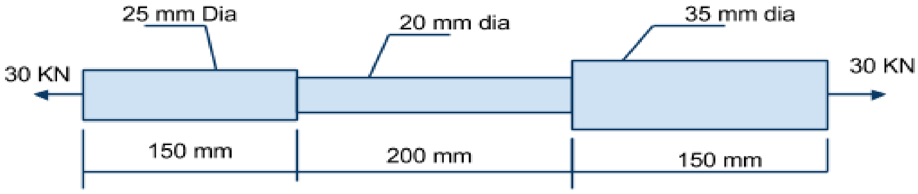
(Ans:E=9.52e3 N/mm2)

9.An alloy bar 1m long and 200mm2 in cross section is subjected to compressive force of 20KN. If the modulus of elasticity is 100GPa. FInd decrease in the length of bar.

(Ans:1mm)

TYPE 2: PROBLEMS ON STEPPED CROSS-SECTION.

1. A copper bar shown in figure is subjected to a tensile load of 30 KN. Determine elongation of the bar if E=100GPa. Also find maximum stress induced.



(Ans:0.33mm, 7.14 N/mm2)

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2. A copper bar 900mm long and circular in section . It consists of 200mm long bar of 40 mm diameter,500 mm long bar of 15 mm diameter and 200mm long bar of 30mm diameter. If the bar is subjected to a tensile load of 60kN,Find the total extension of the bar.Take E=100GPa

(Ans:1.963 mm)

3.A stepped bar ABCD consists of three parts AB,BC and CD such that Ab is 300mm long and 20mm diameter, BC is 400mm long and 30mm diameter and CD is 200 mm long and 40 mm diameter. It was observed that the stepped bar undergoes a deformation of 0.42mm when it was subjected to a compressive load of P N. Find the value of P if E=200 GPa.

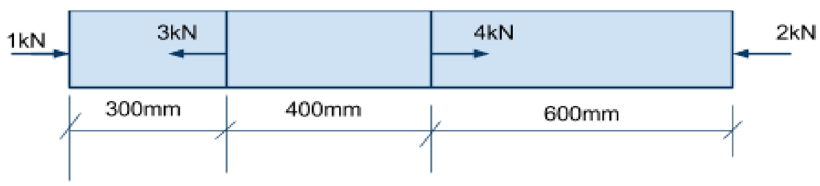
(Ans:50 kN)

4.A steel rod is subjected to axial load of 50 kN. Total length of rod is 4m. First 1m has diameter 32mm, second 1m has diameter 28mm and remaining part has diameter 25mm. If Young's modulus of material is 2 ×105 N/mm2 .Find elongation of the rod.

5.A circular bar of 500mm length has first 100mm of diameter 12mm,second 200mm has diameter 20mm and the last 200mm has diameter of 30mm. Determine the maximum axial pull which the bar is subjected if the maximum stress is limited to 100 N/mm2 .Find the total elongation of the bar.

(Ans: P=11309.3, elongation=0.102)

6.A bar of uniform cross sectional area 100mm2 is subjected to forces as shown below. Calculate the change in the length of the bar.Young's modulus of material is 2 ×105 N/mm2



(Ans:-0.035mm)

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7. *A brass bar, having cross-sectional area of 1000 mm^2, is subjected to axial forces as shown in Fig. 1.9.*

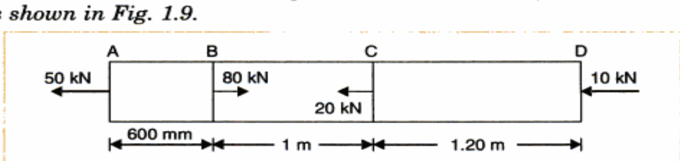
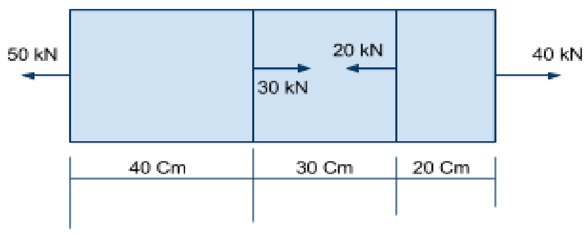


Fig. 1.9

Find the total elongation of the bar. Take E = 1.05 × 10^5 N/mm^2.

(Ans:-0.1142mm)

8.A steel bar of 20mm diameter is loaded as shown in figure. Determine the stresses in each part and the total elongation. Take E=210 GPa.



(Ans:159.23 N/mm2 ,63.69N/mm2 ,127.38 N/mm2 ,elongation=0.5156mm)

3: PROBLEMS ON THREE MODULI OF ELASTICITY

1. A material has Young's Modulus of 2.1 ×105 N/mm2 and Poisson's ratio 0.29. Calculate the Bulk modulus and modulus of rigidity..

(Ans:81.4e3,167e3)

2.A material has Young's modulus of 1.8 ×105 N/mm2 and Bulk modulus 1.2×105 N/mm2 .Find the Poisson's ratio and Modulus of rigidity.

(Ans:0.25,72 ×103 N/mm2)

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3. For a certain material E=2K, determine the Poisson's ratio and find E/G?

(Ans: 0.165,E/G 2.33)

4.If Modulus of rigidity is 75.018 ×105 N/mm 2 and poisson's ratio ⅓. Find E and K.

(Ans:E=20×106 N/mm2 and K=199.9E6 N/mm2)

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5. For a certain material E=2.8K. Calculate the Poisson's ratio. Also calculate the ratio of modulus of elasticity to modulus of rigidity.

(Ans: 0.033, E/G=2.066)

TYPE 4: PROB ON LINEAR ,LATERAL STRAIN AND POISSON'S RATIO

1. A metal rod 20 mm diameter and 2 m long is subjected to a tensile force of 60 kN, it showed and elongation of 2 mm and reduction of diameter by 0.006 mm. Calculate the poisson's ratio and three moduli of elasticity.

(Ans:Poisson's ratio = 0.3,E=190.99e3 N/mm2 ,G=73.45e3 N/mm2 ,K=159.15e3 N/mm2)

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2. A bar of diameter 12 mm is tested on U.T.M (Universal Testing Machine) and following observations were noted 1)Gauge length : 200mm 2) Load on Proportional limit :20kN 3)Change in length at proportional limit : 0.2 mm 4) Change in diameter : 0.0025 mm. Determine Poisson's ratio and three moduli of elasticity.

(Ans:Poisson's ratio = 0.208,E=176.85e3 N/mm2 ,G=73.19e3 N/mm2 ,K=100.94e3 N/mm2)

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3. A metal bar 50mm×50mm in section is subjected to an axial compressive load of 500 kN. If the contraction of a 200mm gauge length was found to be 0.5 mm and the increase in thickness 0.04 mm, find the values of Poisson's ratio and three moduli.

(Ans:E=80Gpa, Poisson's ratio=0.32)

4.In an experiment an alloy bar of 1m long and 20mm×20mm in section was tested to increase through 0.1 mm, when subjected to an axial tensile load of 6.4 kN. If the value of bulk modulus of the bar is 133 GPa, find the value of poisson's ratio

(Ans: Poisson's ratio=0.30)

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5. A steel rod 4 m long and 20mm diameter is subjected to an axial tensile load of 45 kN. Find the change in length and diameter of the rod. E= 200 GPa, and m=4.

(Ans: Change in length=2.86mm, change in diameter=0.003575mm)

6.A steel rod 3m long and 25mm diameter is subjected to an axial tensile load of 60 kN. Calculate the change in length and diameter of rod. E=210 Gpa and Poisson's ratio =0.28.

(Ans: Change in length=1.75mm, change in diameter=0.0041mm)

7.A steel bar 1.2 m long, 40mm wide and 20 mm thick is subjected to an axial tensile load of 50 kN in the direction of its length. Find the change in length and thickness of the bar . E=200 Gpa and Poisson's ratio =0.26.

(Ans: Change in length=0.375mm, change in thickness=1.625×10-3mm)

8.A metal bar 40mm×40mm section, is subjected to an axial compressive load of 480 kN. The contraction of a 200 mm gauge length is found to be 0.4 mm and the increase in thickness 0.04 mm. Find the value of Young's Modulus and Poisson's ratio.

(Ans: E= 150×103 n/mm2 , m=2)

TYPE:5:PROBLEMS ON COMPOSITE SECTIONS

1. A copper rod 30 mm in diameter and 400 mm long is enclosed in a steel tube of internal diameter 30mm and thickness 10mm and are rigidly attached to act as a composite bar. Bar is subjected to an axial load of 200kN. Find 1. Stress in each material. 2. Load shared by each material 3.Elongation of the composite bar. Es=200 kN/mm2 and Ec=100 kN/mm2 .

(Ans:stress in copper=62.11Mpa,stress in steel=124.22Mpa,Ps=156 kN,Pc=44 kN & elongation=0.248 mm)

2.A mild steel rod 20 mm diameter and 300 mm long is enclosed centrally inside a hollow copper tube of external diameter 30mm and internal diameter 25mm. THe ends of the rod and tube are brazed together, and the composite bar is subjected to an axial pull of 40 kN. FInd the stresses in the rod and the tube E for steel is 200 GPa and for Copper is 100 GPa.

(Ans:stress in copper=47.4 Mpa,stress in steel=94.8 Mpa)

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3. A composite bar is made up of steel rod of diameter 20 mm rigidly fixed rigidly fitted into copper tube of internal diameter of 20mm and external diameter of 30mm. If this composite section which is 750 mm long is subjected to a Compressive load of 30 kN, find the stresses developed in the steel rod and copper tube. Take Es=200 GPa, Ec= 100 GPa. Also determine the change in length of bar..

(Ans:stress in copper=29.4 Mpa,stress in steel=58.8 Mpa, dl=0.22mm)

4.A composite bar is made up of a brass rod of 25mm diameter enclosed in a steel tube of 40 mm OD and 35 mm ID. The ends of the rod and tube are securely fixed. Find the stresses in brass and steel if it is subjected to a pull of 45 kN. Take Es=200 GPa,Eb=80 GPa.

(Ans:stress in barss=36.6 Mpa,stress in steel=91.5 Mpa)

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5. Two vertical rods are made up of steel and copper are 30 mm each and 400 mm long are rigidly held at top. A horizontal cross bar of copper is fixed to the rods at lower ends which carry 6000 N such that the cross bar remains horizontal even after loading. Calculate load shared by each rod. Es=200 Gpa and Ec=100Gpa. (Ps=4000N,Pc=2000 N)

TYPE 6: PROBLEMS THERMAL STRESSES IN BARS

1. A brass rod 2m long is fixed at both its ends. If the thermal stress is not to exceed 76.5 MPa, calculate the temperature through which the rod should be heated . Take the vale of alpha as 17×10-6 /K and E=90 GPa.

(Ans:t=50 K)

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2. A steel bar, fixed at its both ends, is heated through 15 K. Calculate the stress developed in the bar, if modulus of elasticity and coefficient of linear expansion for the bar material is 200 GPa and 12×10-6 /K respectively.

(Ans:stress 36 Mpa,)

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3. An alloy bar 2m long is held between two supports. FInd the stress developed in the bar, when it is heated through 30 K if both the ends (i) do not yield (ii) yield by 1 mm. Take the value of e and alpha for the alloy as 120 GPa and 24×10-6 /K .

(Stress= 86.4 MPa, 26.4 Mpa)

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4. An alloy bar 6m long is held between two supports by a steel rod 25 mm diameter passing through metal plates and nuts at each end.. The rod is held at temp. of 100 ^{0} C.Determine the stress in the rod, when the temperature falls down to 60 ^{0} C, if

(i) do not yield

(ii) yield by 1 mm. Take the value of e and alpha for the alloy as 200 GPa and alpha = 12×10-6 /K .

(Stress= 96 MPa, 62.6MPa)

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5. Two parallel walls 6m apart are stayed together by a steel rod 2.5 cm diameter at a temperature of 80 0 c passing through washers and nuts at each end. Calculate the pull exerted by the rod when it has cooled to 22^0 C if,

(i) do not yield (ii) yield by 1.5 mm. Take the value of E & alpha for the alloy as 200 GPa and 11×10-6 /K .

(Stress= 127.6 kN, 77.6m/mm2)

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6. A steel bar of 30 mm diameter is heated to 80^0 C and then clamped at the ends. It is then allowed to cool down to 30^0 c. During cooling, only 1 mm contraction was allowed. Calculate the temperature stress developed and reaction at the clamps.Take the value of e and alpha for the alloy as 200 GPa and 12×10-6 /K .Take length of bar 10 meters.

(F=70.68 KN)

TYPE 7: PROBLEMS ON PUNCHING SHEAR STRESS

1. A steel punch can be worked to compressive stress of 800 N/mm2 . Find the least diameter of the hole which can be punched through a steel plate of 10 mm thick if ultimate shear stress of the plate is 300 N/mm2 .

(Ans:d=15mm)

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2. A Circular hole of diameter 20 mm is to be punched through a plate of 10 mm thick. Find the force required to punch a hole, if shear strength of material is 250 N/mm2 .Hence find the compressive stress developed in the punch material.

(Ans:F=157.079 kN, Comp stress=500 N/mm2)

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3. Determine the smallest size of hole that can be punched in 12 mm thick MS plate having ultimate shear stress of 390 N/mm2 , if permissible crushing stress for the punch material is 2.4 kN/mm2.

(Ans:d=78mm)

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4. A force of 31.68 kN is required to punch a circular hole of 14 mm diameter in metal plate of 2 mm thickness. Calculate the ultimate shear stress and compressive stress developed in the punching rod.

(Ans:Shear Stress=360.32 N/mm2 ,Comp.Stress=205.90 N/mm2)

TYPE 8 : PROBLEMS ON EULER'S FORMULA

1. A steel rod 5m long and 40 mm diameter is used as a column, with one end fixed and the other free. Determine the crippling load by Euler's formula. Take E=200 Gpa

(Ans:2.48 kN)

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2. A circular steel bar of 10 mm diameter and 1.2m long is subjected to compressive load in a testing machine. Assuming both ends hinged, determine Euler's crippling load.Take E=200 GPa. Also calculate safe load if F.O.S is 3.

(Ans 672.87N, safe load=224.29 N)

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3. A hollow alloy tube 4m long with external and internal diameters 40mm and 25mm respectively has both ends pinned. Find the crippling on the tube without buckling. Take E=65200 N/mm2

(Ans4.29 kN)

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4. A hollow cast iron column of 150 mm external diameter and 100mm internal diameter is 3.5m long. If one end of the column is rigidly fixed and other is free, find the critical load on the icolumn taking modulus of elasticity for the column material as 120 GPa.

(Ans:482 kN)

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5. A 1.75 m long steel column of rectangular cross section is 120mm×100mm is rigidly fixed at one end and hinged at the other end. Determine the buckling load on the column and the corresponding axial stress using Euler's formula. Take E=200 Gpa ***(Ans:*** $12.84 \times 10^6 N, 1070\ N/mm^2$ ***)***

TYPE 9: PROBLEMS OF FINDING STRESSES ON A GIVEN PLANE.

1. At a point in strained material two stresses on mutually perpendicular planes ar 400 N/mm2 and 200 N/mm2, both tensile. Find the normal , tangential and resultant intensity of stress on an oblique plane at 60 degrees from the plane of stress 400 N/mm2.

{Ans $\sigma_n = 250\ N/mm^2, q_t = 86.67\ N/mm^2, \sigma_r = 264.6 N/mm^2$}

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2. At a point in strained material material a tensile stress of 250 MPa in the horizontal direction and another tensile stress of 100 MPa in the vertical direction. The point is also subjected to the simple shear stress of 25 MPa . What is the magnitude of the normal and shear stress on a section inclined at an angle of 20 degrees with the major tensile stress?

{Ans $\sigma_n = 101.48\ N/mm^2, q_t = 29.06\ N/mm^2$}

3.The stresses at a point in a component are 100 MPa(Tensile) and 50 MPa(comp). Determine the magnitude of the normal and shear stresses on a plane inclined at an angle of 25 degrees with the tensile stress. Also determine the resultant, its direction and the magnitude of the maximum intensity of shear stress.

{ Ans:

$\sigma_n = -23.21\ N/mm^2, q_t = 57.45\ N/mm^2,, \sigma_r = 61.96\ N/mm^2, \theta = -68^0, \tau_{max} = \pm 75\ MPa\}$

4. A point in a strained material is subjected to a tensile stress of 120 MPa and a clockwise shear stress of 40 MPa. What are the values of normal and shear stresses on a plane inclined at 25 degrees with the normal to the tensile stress?

{Ans $\sigma_n = 67.92\ N/mm^2, q_t = 71.67\ N/mm^2\}$

}

5. A point is subjected to tensile stresses of 200 MPa and 150 MPa on two mutually perpendicular planes and and anticlockwise shear stress of 30 MPa. Determine the values of normal and shear stresses on a plane inclined at 60 degrees with the minor tensile stress.

{Ans $\sigma_n = 188.48\ N/mm^2, q_t = 36.65\ N/mm^2\}$

TYPE 10: PROBLEMS ON FINDING THE PRINCIPAL STRESSES AND PLANES.

1. At a point in strained material , the stresses are as below:

a) 300 MPa tensile in x direction b) 150 MPa compressive in y direction

c) 200 MPa complementary shear stress.

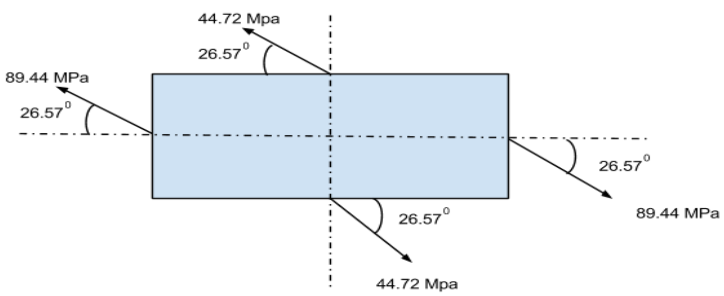
Find the major principal stress, minor principal stress and their position..Also find max shear stress.

{Ans $\sigma_{p1} = 376\ N/mm^2, \sigma_{p2} = -226\ N/mm^2, \theta = 20.8\ and\ 110.8\ , q_{tmax} = 301\ N/mm^2\}$

2.At a point in sttrained material there is a tensile stress of 80 MPa in horizontal direction and a compressive shear stress of 40 MPa in vertical direction. There is also a shear stress of 48 Mpa acting upon each of these planes. Determine the planes of maximum shear stress at the point along with its magnitude.

{Ans $q_{tmax} = 76.84\ N/mm^2, \theta = 64.33^0\}$

3) Resultant stresses on two mutually perpendicular planes are as shown in figure. Calculate principal stresses and their directions.



$\sigma_{p1} = 100\ N/mm^2, \sigma_{p2} = 0\ N/mm^2, \theta = 26.56\ and\ 116.56\ \}$

4) At a point in a stressed element, the normal stresses in two mutually perpendicular directions are 45 MPa and 25 MPa both tensile. The complementary shear stress is 15 MPa. Determine the maximum and minimum principal stresses.

$\sigma_{p1} = 188.48\, N/mm^2, \sigma_{p2} = 36.65\, N/mm^2$ }

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5. At a point in a strained body there are normal tensile stresses of 60 MPa and 40 MPa acting on two mutually perpendicular planes together with the shear stress of 10 MPa. Locate the principal plane and determine the principal stresses.

$\sigma_{p1} = 64.142\, N/mm^2, \sigma_{p2} = 35.85\, N/mm^2, \theta = 22.5\ and\ 112.5\ , q_{tmax} = 301\, N/mm^2$ }

TYPE 11: PROBLEMS ON THIN CYLINDRICAL SHELLS

1.A steam boiler of 800mm diameter is made up of 10 mm thick plates .If the boiler is subjected to an internal pressure of 2.5MPa,find the circumferential longitudinal stresses induced in the boiler plates.

[Ans. $\sigma_c = 100 MPa,\ \ \sigma_l = 50\, MPa$]

2.A cylindrical shell of 1.3m diameter is made up of 18mm thick plates.Find the circumferential and longitudinal stress in the plates, if the boiler is subjected to an internal pressure of 2.4MPa.Take efficiency of the joints as 70%.

[Ans. $\sigma_c = 124\, MPa,\ \ \sigma_l = 62\, MPa$]

3.A gas cylinder of internal diameter 40mm is 5mm thick. If the tensile stress in the material is not to exceed 30 MPa ,find the maximum pressure which can be allowed in the cylinder.

[Ans. $p = 7.5 MPa,\ \ p = 15\, MPa$]

4.A thin cylindrical shell of 400 mm diameter is to be designed for an internal pressure of 2.4MPa .Find the suitable thickness of the shell, if the allowable circumferential stress is 50 MPa.

[Ans. $t = 9.6 mm$]

5.A cylindrical shell of 500mm diameter is required to withstand an internal pressure of 4MPa .Find the minimum thickness of the shell ,if maximum tensile strength in the plate material is 400 MPa and efficiency of the joints is 65%,Take factor of safety as 5.

[Ans. $\sigma_c = 80 N/mm^2,\ \ t = 19.2 mm$]

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6. A cylindrical shell 2m long and 1 m internal diameter is made up of 20 mm thick plate. Find the circumferential and longitudinal stresses in the shell material ,if it is subjected to a pressure of 5MPa.

[Ans. 125 MPa, 62.5MPa]

7.A steam boiler of 1.25 m in diameter is subjected to an internal pressure of 1.6MPa. If the steam boiler is made up of 20 mm thick plates, calculate the circumferential and longitudinal stresses . Take efficiency of the circumferential and longitudinal joints as 75% and 60% respectively.

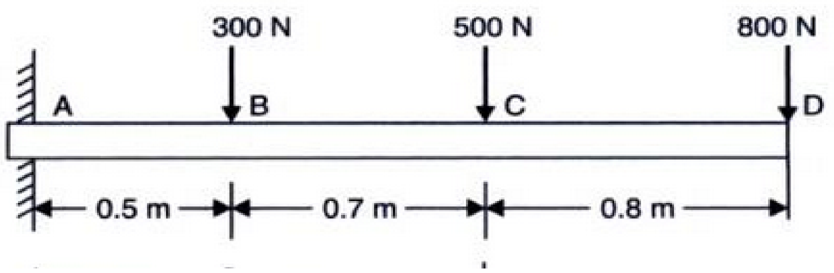
[Ans. 67 MPa, 42 Mpa]

8.A pipe of 100mm diameter is carrying a fluid under a pressure of 4MPa .what should be the minimum thickness of the pipe ,if maximum circumferential stress in the pipe material is 12.5 MPa.

[Ans.16mm]

TYPE 12. PROBLEMS ON CANTILEVER BEAM

Prob.1. Draw Shear force and Bending moment diagram for loading shown below.



Prob.2.Draw bending moment and shear force diagram of a cantilever beam having AB 4 meters long having its fixed end at A and loaded with a uniformly distributed load of 1 kN/m upto 2 meters from A and with a concentrated load of 2 kN at 1 m from B.

Prob.3.Draw bending moment and shear force diagram of a cantilever beam having AB 4 meters long having its fixed end at A and loaded with a uniformly distributed load of 1 kN/m upto 2 meters from A and with a concentrated load of 2 kN at 1 m from B.

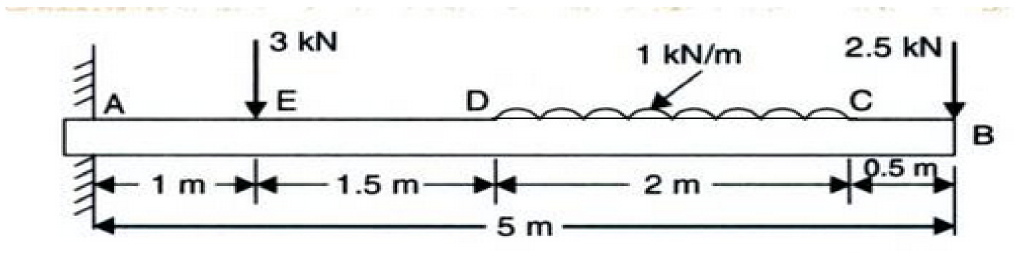
Prob 4. A cantilever beam ABCD is fixed at A and free at D ,such that AB=1 m, BC= 2m, CD= 3.5 m. It carries an udl of 150 kN/m from B and D along with a point load of 500 kN at point C. Draw shear force and bending moment diagram for this beam.

Prob 5. A cantilever 2.4 m long carries point loads of 20 kN and 50 kN at free end and 1.68 m from free end respectively. It also carries uniformly distributed load of 30 kN/m starting from 0.24 m to 1.2 m from free end. Draw SFD and BMD.

Pr 6. Draw shear force and bending moment diagram for a cantilever beam AB of 4 m long having its fixed end at A and loaded with uniformly distributed load of 2 kN/m over entire span and point load of 3 kN acting upward at the free end of cantilever. Find point of contraflexure if any.

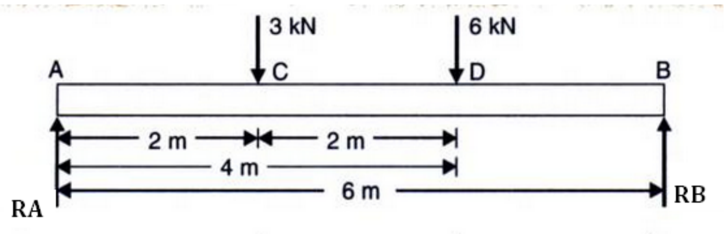
Prob 7. A cantilever beam of span 6 m carries point loads of 8 kN, 6 kN and 4 kN at free end and 2 m, 4 m from free ends respectively. Draw SFD & BMD.

Prob 8. Draw SFD and BMD



TYPE 13 : PROBLEMS ON SIMPLY SUPPORTED BEAM

1.Draw SFD and BMD for diagram



2.A simply supported beam of span 6 m carries two point loads of 30 kN each at 2 m and 4 m from left support. The beam also carries a U.D.L. of 20 kN/m between two point loads. Draw S.F.D. and B.M.D.

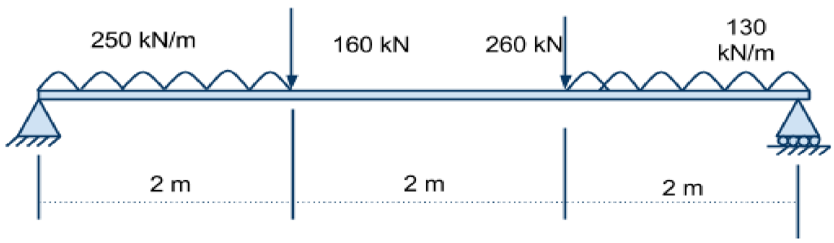
3. Draw S.F.D. and B.M.D. for a beam whose left support is hinge and right support is roller. The beam has following details :

(i) Span = 8 m

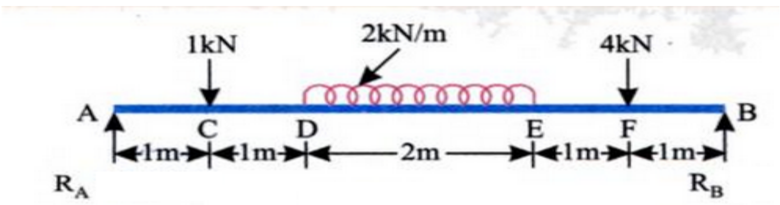
(ii) U.D.L. of 20 kN/m at 4 m from left support.

(iii) A point load of 120 kN at a distance of 6 m from LHS.

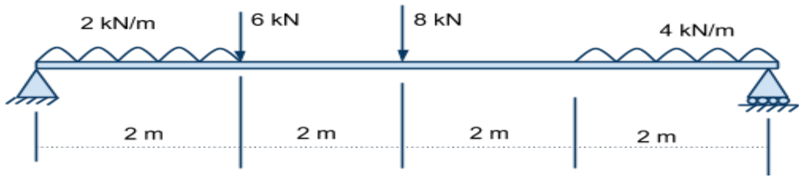
4. Draw Shear force and bending moment diagrams



5. Draw Shear force and bending moment diagram



6. Draw Shear force and bending moment diagram.



7. A simply supported beam ABC has 5m span,is supported between A and C. It carries uld of 20 kN/m over its entire span. It also carries a point load of 45 kN at a distance of 2m from left hand support. Draw shear force and bending moment diagram.

8. A simply supported beam ABCD is of 5m span, such that AB=2m, BC=1 m and CD=2m. It is loaded with 5 kN/m over AB and 2 kN/m ovr CD. Draw shear force and bending moment diagrams for the beam..

TYPE 14 . PROBLEMS ON OVERHANGING BEAM

d) Find the support reaction for the following sketch (refer fig. No. 2) and draw shear force and bending moment diagram. Find the point of contra flexure if any.

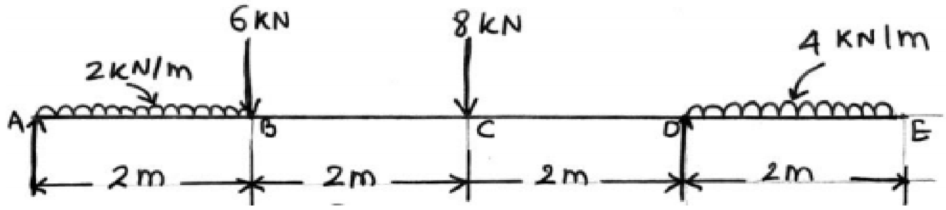


Fig. No. 2

Que. No. 3(d)

2. A beam ABC is supported at A and B. It is loaded with u.d.l of 20kN/m on entire beam and a point load of 10 kn at C. Span Ab is 5m and overhang BC is 1m. Draw shear force and bending moment diagram..

3.A simply supported beam ABC which supported at A and B, 6 m apart with an overhang BC 2 m long, carries a udl of 15 kN/m over AB and a point load of 30 kN at C. Draw S.F. and B.M. diagrams.

TYPE 15:PROBLEMS ON STANDARD CASES OF SFD AND BMD

1.Draw shear force and bending moment diagram for a simply supported beam of span 'L' meters carrying a point load of 'W' Newton at its center

2.Draw shear force and bending moment diagram for a simply supported beam of span 'L' meters carrying UDL of 'W' N/m over entire span.

3.Draw Shear force and bending moment diagram for a cantilever beam of span 'L'meters carrying a point load of 'W' Newton at its free end.

4.Draw Shear force and bending moment diagram for a cantilever beam of span 'L'meters carrying UDL of 'W' Newton at its free end.

TYPE 16. PROBLEMS ON PARALLEL/PERPENDICULAR AXIS THEOREM.

1.Determine the MI of a triangular section having base 5 cm and 6 cm height about its base.

{Ans: $I_{base} = 90cm^4$}

2.A triangular section has base 100 mm and 300 mm height determine moment of inertia about the centroidal axis parallel to axis 1)MI about axis passing through base 2)MI about axis passing through base 3) MI about axis passing through ape

{Ans: $I_{base} = 225 \times 10^6 mm^4, I_{gg} = 75 \times 10^6 mm^4, I_{apex} = 675 \times 10^6 mm^4$}

3.Find the moment of inertia of a hollow circular section having external diameter 100 mm and internal diameter 80mm about,
1) Axis passing through center 2) About tangent to the outer circle and parallel to xx axis. 3) About tangent to inner circle

{Ans: $I_{xx} = 2.89 \times 10^6 mm^4, I_{pq} = 9.94 \times 10^6 mm^4$}

4.Find the moment of inertia of a hollow rectangular section about its centre of gravity, if the external dimensions are 40 mm deep and 30 mm wide and internal dimension ar e25 mm and 15mm wide.

{Ans: $I_{xx} = 140470\ mm^4, I_{yy} = 82970\ mm^4, I_{AB} = 7.41 \times 10^6 mm^4$}

---

5. An isosceles triangular section ABC has base width 80 mm and height 60mm. Determine the moment of inertia of the section about the centre of gravity of the section and the base BC.

{Ans: $I_{xx} = 480 \times 10^3 mm^4, I_{pq} = 1440 \times 10^3\ mm^4$}

6.A hollow C.I. pipe with external diameter 100 mm and thickness of metal 10 mm is used as a strut. Calculate the moment of inertia and radius of gyration about its diameter.

{Ans : $I_{xx} = 2.89 \times 10^6 mm^4, K_{xx} = 32.017\ mm$ }

7.A circular disc has M.I. about its any tangent is $6.283 \times 10^5 mm^4$**. Find the diameter of the disc.**

{Ans: $d = 40\ mm$}

8.An equilateral triangle has a side of 150 mm. Find the moment of inertia about any of its sides.

{Ans: $I_{pq} = 27.404 \times 10^6 mm^4$}

9.Find MI of an equilateral triangle of side 2m about its base.

{Ans : $I_{pq} =$ mm^4}

10.A semicircular lamina has a base diameter 140mm. Calculate the moment of inertia
1) about centroidal axis 2) about base.

{Ans: $I_{xx} = 2.64 \times 10^6 mm^4, I_{pq} = 9.428 \times 10^6 mm^4$}

11.Calculate Polar MI of a square section having 200mm as side.

{ Ans: }

12.Calculate polar moment of inertia for a circle having diameter 250 mm.

{Ans: }

TYPE 17. PROBLEMS ON COMPOSITE STANDARD SECTION.

1. Find MI of a "T" section about its centroidal axis having following dimensions,
1) Flange=200 mm ×40 mm 2) Web= 200 mm × 40 mm

{Ans: $I_{xx} = 85.33 \times 10^6 mm^4, I_{yy} = 27.733 \times 10^6 mm^4$}

---

2) Find Ixx and Iyy for an unequal angle 100 × 80×10 mm. 100 mm leg is horizontal.

{Ans: $I_{xx} = 0.952 \times 10^6 mm^4, I_{yy} = 1.672 \times 10^6 mm^4$}

---

3) Find MI of a T section 200 × 20 mm flange and 180× 20 mm web about x axis.

{Ans: $I_{xx} = \qquad mm^4$}

4}A symmetrical I section has the following dimensions,
Flanges=100mm × 10mm, Web=10 mm × 100 mm. Calculate Polar MI of the section.

{Ans: $I_P = 8.575 \times 10^6 mm^4$}

---

5)Calculate Ixx and Iyy for an unequal angle section 70 × 50×10 mm. Take 70 mm leg vertical

{Ans: $I_{xx} = 518.25 \times 10^3 mm^4, I_{yy} = 218.25 \times 10^3 mm^4$}

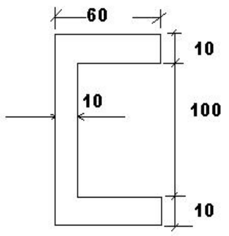
---

6)Determine Moment of inertia about xx and yy axis of I section having following dimensions Top flange : 20 × 80 mm, Web : 10 × 280 mm, Bottom Flange : 120 × 20 mm

{Ans: Ixx=106.4 $\times 10^6 mm^4$, Iyy = 3.756 $\times 10^6 mm^4$ }

---

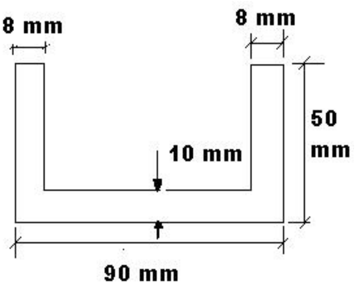
7) A c Channel is shown below find its Moment of inertia about xx and yy axis.



{Ans: Ixx = 4.4733 $\times 10^6 mm^4$, Iyy = 729.48 $\times 10^3 mm^4$}

---

8. Find the radius of gyration of the channel section about the centroidal axis as shown below



{Ans: Ixx=327.05 $\times 10^3 mm^4$}

TYPE 18 : PROBLEMS ON COMPOSITE SECTIONS

c) A lamina consist of a semicircle and a triangle shown in Fig. 4. Calculate its M.I. about reference axis AB.

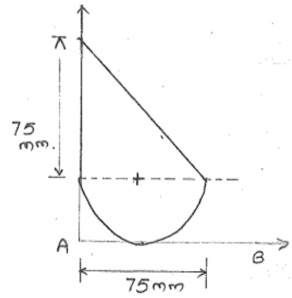


Fig. 4

Problem 2.6

Determine the moment of inertia about the aixs AB of the Lamina with a circular hole as shown in Fig. 2.6.

Solution

(i) Moment of inertia of the triangle ABC about the axis

$AB = \frac{8 \times 8^3}{12} = 341.33\ cm^4$

(ii) Moment of inertia of the semicircle about the axis

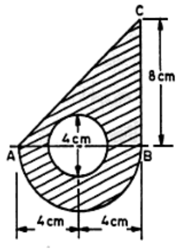


Fig. 2.6

TYPE 19: PROBLEMS ON BENDING STRESSES IN BEAMS

1. A Circular beam 500 mm dia is simply supported over span of 6m. It carries point load of 81 KN at center. Find bending stress induced.

(Ans f= 9.92 N/mm^2)

---

2. A simply supported beam of span 4m carries uld of 2 Kn/m over the entire span. if the bending stresses is not to exceed 165 N/mm2, find the value of section modulus for the beam and diameter of beam when it is circular.

(Ans d=)

---

3. A rectangular beam 200 x 450 mm is fixed at one end as a cantilever beam of span 4m it carries udl of 100 N/m over entire span. Find bending stress

(Ans f= $0.119\ N/mm^2$)

---

4. A rectangular beam 300 mm deep is simply supported over span of 4m. Find what udl beam can carry is bending stresses is limited to 120 mpa.

(Ans W = 90 N/mm)

---

5. A rectangular beam 60 mm wide and 150 mm deep is simply supported over a span of m. if the beam is subjected to audl of 4.5 KN/M and max. bending stress is limited to 40 mpa Find span of beam.

(Ans x= 4008 mm)

---

6. A rectangular beam 60 mm wide and 150 mm depth is simply supported over 6m. If beam has point load of 12KN at center. Find max. bending stress include.

(Ans F= $80.02\ N/mm^2$)

---

7. A beam is rectangular section supports A load of 20 kn at center of beam span 3.6 m. If depth is twice width and stress is limited to 7 mpa find dimension of beam.

(Ans x = 156.82 mm)

---

8. A hollow steel tube as external dia is 100 mm and internal dia 75 is simple supported over 3 m span . It carries pt load of W kn at center find W if bending stress is 100 mpa.

(Ans W = 5360 kw)

---

9. Calculate max stress induced in a CI pipe of ext. dia 40 mm and internal dia 25 mm length of pipe is 4 m and simply supported and carries pt load of 80 kN at center.

(Ans f =$15.02 \times 10^3\ N/mm$)

10. A beam of rectangular c/s has depth 150 mm is supported at one end as cantilever is bending stress is limited to 30 mpa find max. udl it can carry take I = $7.5 \times 10^6 mm^4$

(Ans W = 1.5 N/mm)

11. A cantilever beam 80 mm x 120 mm carried pt load of 6 kn at end, It bending stress is limited to 40 mpa find span.

(Ans L = 1280 mm)

12. A rectangular beam simply supported over span 4m, carries UDL of 50 Kn/m over span. It depth of section is 2:5 width find dimension of bending stress is limited to 60 mpa.

(Ans b = 117.02 mm, d = 292.55 mm)

TYPE 20:SHEAR STRESS IN BEAM:

1. A rectangular section 230 mm wide and 400mm deep is subjected to shear force of 40 KN find max. shear stress across section.

(Ans =** $0.645\, N / mm^2$**)

2. A circular has 50 mm carries shear force of 120 KN find Average and max shear stress

(Ans =** $81.48\, N / mm^2$**)

3. A circular beam has dia 100 mm has max shear stress 2.122 N/mm^2 Find shear force acting on it.

(Ans = f = $12.5 \times 10^3 N$)

4. A rect. beam 100 mm wide is subjected to shear force of 50 KN its max shear stress is 4 mpa find depth.

(Ans = d = 187.5 mm)

TYPE 21: PROBLEM ON DIRECT AND BENDING STRESS

1. A rectangular mild steel flat 150mm. wide and 12.mm thick carry tensile load of 180kn at on eccentricity of 10mm in plane bisecting the thickness find max and min intensity of stress.

(Ans = $\sigma_{min} = 6\, N / mm^2$)

2. A rectangular column 300mm wide and 500mm deep carries load of 100 kn at the eccentricity of 30 mm in the plane bisecting thickness calculate max and min stresses.

3. A circular section 300mm dia carries 100Kn at eccentricity of 30mm find max and min stress eccentricity.

(Ans 2.54 n/mm2 = $\sigma_{min} = 0.283\, N / mm$)

4. A hollow circular section having external dia 300mm and internal dia 250mm carries a load of 100Kn at an eccentricity of 125mm calculate the max and min intensities of the stress in the section.

(Ans max st=13.73 = $\sigma_{min} = -4.47\, N / mm^2$)

5. A hollow rectangular column section 600mm by 300mm outer dimensions and 500mm by 250mm internal dimension carries a load of 15Kn at an eccentricity of 100 mm in the plane bisecting thickness calculate the maximum and minimum intensities of stress in section.

(Ans = $\sigma_{min} = 0.111\ N/mm^2$)

---

6. A circular bar having 200mm diameter is subjected to a load of 300 Kn is acting an eccentricity of "e" mm from center if max. stress is limited to 12 N/mm^2. find the value of e.

(Ans = e = 6.44mm)

---

7. A rectangular mild steel flat 150 mm wide and 120 mm thick carries a load of 180 Kn in a plane bisecting thickness if max stress is 14 N/mm^2, Find e.

(Ans = e = 10 mm)

TYPE 22: CONDITION FOR NO TENSION AT BASE OF SECTION

1. Calculate limit of eccentricity for a circular section having dia 50mm

2. Find the limit of eccentricity for a circular section having dia d mm

3. Calculate limit of eccentricity for a square section having side 20mm.

4. Calculate limit of eccentricity for a square section having side a mm

5. Calculate limit of eccentricity for a rectangular section having size $b \times d$***mm***

TYPE 23: PROBLEMS ON C CLAMP

1. A rectangular section 50mmx100mm is bent into c shape as shown in fig find stress developed at section x-x

(Ans = $\sigma_{max} = 152.23\ N/mm^2$)

---

2. A 'C' camp is made of section 250×30***mm It has eccentricity of 400mm. It carries load of 100Kn find max and min stress in section.***

(Ans = $\sigma_{max} = 141.33\ N/mm^2$, $\sigma_{min} = 114.67\ N/mm^2$)

---

3. A C clamp is made up of 30 x 100 mm as shown find max and min stress in section A-A

(Ans = $\sigma_{max} = 175\ N/mm^2$, $\sigma_{min} = 158.33\ N/mm^2$)

---

4. A m.s. link shown carries load 80Kn find B and t it B = 3t It allowable stress is 70 mpa.

(Ans = t = 20, B= 60mm)

TYPE 24 : TO FIND POWER TRANSMITTED BY SHAFT

Prob 1.Find the power transmitted by a shaft of 25mm diameter running at 400 rpm. Take Allowable shear stress for shaft material as 65 Mpa.

{Ans:P=8.35 Kw}

Prob 2. A solid shaft of diameter 60 mm is running at 150 rpm. Find the power that can be transmitted by the shaft if permissible shear stress is 80 N/mm^2 ***Maximum torque is likely to exceed 30% more than mean torque. {i.e. Tmax=1.30 T avg}***

{ Ans:P=40.84 Kw}

Prob 3. Find the power that can be transmitted by a hollow shaft having external diameter 200mm and internal diameter 120 mm. The shaft is running at 110 rpm. Allowable shear stress for the material is 63 Mpa.Maximum torque is likely to exceed 20% more than mean torque.

{ Ans:826.78 Kw}

Prob 4.A hollow shaft of external and internal diameters as 100mm and 40mm is transmitting power at 120 rpm. Find the power it can transmit if the shearing stress is not to exceed 50mpa.

{ Ans:120.13 KW}

Prob 5. Find the Power that a solid shaft of 100 mm diameter running at 500 rpm can transmit ,if angle of twist is 1.5^0 ***in a length of 2m.G=70 GPa.***

{ Ans:471 KW}

Prob 6.A hollow shaft of external and internal diameters as 80mm and 40mm is required to transmit torque from one pulley to another. What is the value of torque transmitted, if the angle of twist is not to exceed 1^0 ***in a length of 2 meters. Take modulus of rigidity as 80 Gpa.***

{ Ans:T=$2.63\times10^3\ N-mm$***}***

Prob 7. What is the torque induced in a solid circular shaft of diameter 50 mm rotating at 100 rpm , if the permissible shear stress is not to exceed 75 Mpa.

{ Ans: $Torque=1.84\times10^6\ N-mm$ ***}***

Prob 8. A solid circular shaft of 30 mm diameter is subjected to a torque of 250 N-M causing an angle of twist 3.74^0 ***in a length of 2m. Determine the modulus of rigidity of the material of the shaft.***

{ Ans: $G=96.73\times10^3\ N/mm^2$ ***}***

TYPE 25: TO FIND THE DIAMETER/DIAMETERS OF SHAFT

prob 1: A solid steel shaft has to transmit 100 KW at 160 r.p.m. Taking allowable shear stress as 70 MPa, find the suitable diameter of the shaft. the Maximum torque transmitted in each revolution exceeds the mean by 20%.

{ Ans:d=80 mm}

Prob 2: Select a suitable diameter for a solid circular shaft to transmit 200 HP at 180 rpm. The allowable shear stress is 90 Mpa and allowable angle of twist is 1^0 ***for every 5m length of shaft . Take C/G =*** $0.82\times10^5 N/mm^2$

{ Ans: d from fs=................, d from angle=....................., suitable diameter=..................... }

Prob 3: A shaft is transmitting power of 50.5 kw at 120 rpm. if the shear stress is not to exceed 40 MPa,find the suitable diameter of the shaft.

{ Ans:d=80 mm}

Prob 4: A solid shaft is subjected to torque of 1.6 KN-m. Find the necessary diameter of the shaft, if the allowable shear stress is 60 Mpa. the allowable twist is 1^0 for every 2m length of shaft c=80 Gpa.

{ Ans:d=51.4,d=61.6}

Prob 5: A shaft is transmitting 100 kW at 180 r.p.m if the allowable shear stress in the shaft material is 60 MPa, determine the suitable diameter for the shaft. The shaft is not to twist more than 1^0 in a length of 3 meter. G=80 GPa.

{ Ans:d=103.8}

Prob 6: A shaft has to transmit 105 KW at 160 rpm. If the shear stress is not to exceed 65 Mpa and in the length of 3.5m must not exceed 1^0, find the diameter of the shaft. Take C=$8\times10^5 N/mm^2$

{ Ans: }

Prob 7. A solid circular shaft of 100 mm diameter is transmitting 120 kW at 150 r.p.m. Find the intensity of shear stress in the shaft.

{ Ans:fs=39 Mpa}

HOLLOW SHAFT

Prob 8. A hollow shaft is to transmit 200 kW at 80 RPM. If the shear stress is not to exceed 60 MPa and internal diameter is 0.6 of the external diameter, find the diameter of the shaft.

{ Ans:D=132 mm,d= 79.2 mm}

Prob 9: A hollow shaft of diameter ratio ⅗ is required to transmit torque of 61465 N-m. the shear stress is not to exceed 63 MPa and twist in a length of 3m diameter is 1.4^0 Calculate the minimum external diameter satisfying these conditions Take G=84 Gpa.

{ Ans: }

Prob 10: A hollow shaft is required to transmit a torque of 36 kN-m. The inside diameter is 0.6 times the external diameter. Calculate both diameters if the allowable shear stress is 83 MPa.

{Ans: D=............, d=.................. }

Prob 11: A hollow shaft is required to transmit a torque of 40 kN-m. The inside diameter is 0.5 times the external diameter. Calculate both diameters if the allowable shear stress is 50 MPa.

{Ans: D=............, d=.................. }
