Shaikh Sir's Diploma Classes

Sub:Strength of Material (22306)

UNIT 2. Simple Stress and Strains

2.1 Equilibrium,Rigid body, Deformable body.

2.2 Axial Stress-Meaning, Resistance, Types of Stresses ;
Axial(linear) Strain – Concept types.

2.3 Hooke's Law. Young's Modulus, Axial
deformation in a body and bodies in series.

2.4 Behavior of ductile and brittle materials
subjected to axial tension. Stress-strain or
Load-deformation curve, Limit of proportionality,
yielding, permanent set, yield stress. ultimate stress.

2.5 Shear stress and shear strain, Modulus of
rigidity. punching shear, shear connectors,
single and double shear.

2.6 Temperature stress and strain in case of
bodies having uniform cross—section,
deformation fully prevented, field examples.

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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. Also calculate strain induced in the bar.

(Ans: 3.75mm,e=7.5E-3)

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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= 20.0 N/mm2 , Deformation= 0.4 mm)

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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.

(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 1600 KN without the stress exceeding 90 MPa.

(Ans: d=250.25 mm)

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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×.103 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 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

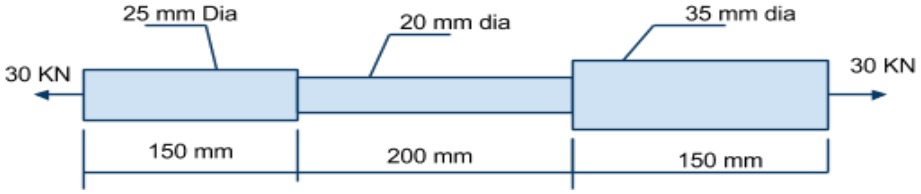
(Ans:E=9.52e3 N/mm2)

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, 95.49 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)

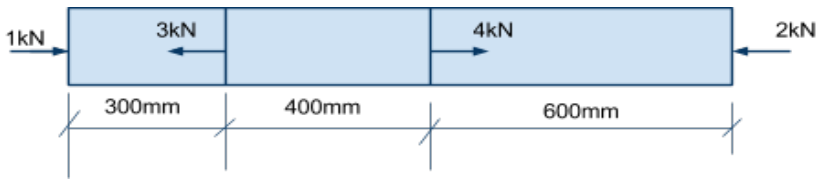
4.A steel rod is subjected to axial load of 50 kN. Total length of rod is 4m. First 1m has diameter 32mm, second 1m has diameter 28mm and remaining part has diameter 25mm. If Young's modulus of material is 2 ×105 N/mm2 .Find elongation of the rod.

(Ans:1.73 mm)

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.E= 2 ×105 N/mm2

(Ans: P=11309.3 N, 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 mm², is subjected to axial forces as shown in Fig. 1.9.*

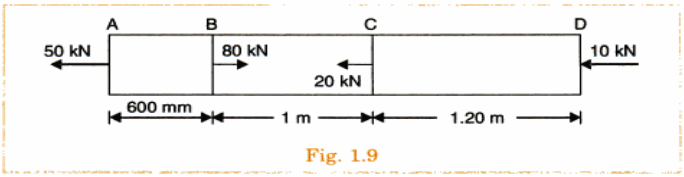
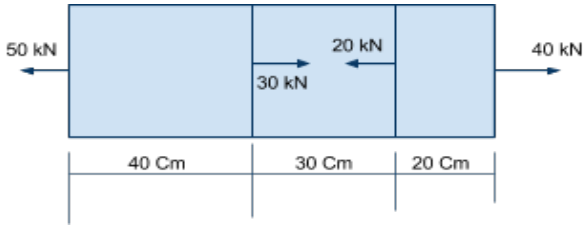


Fig. 1.9

Find the total elongation of the bar. Take E = 1.05 × 10⁵ N/mm².

(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)

Type 3: 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 220 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 800 C and then clamped at the ends. It is then allowed to cool down to 300 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 4: Problems on 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=7.8mm)

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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)