Shaikh Sir's Diploma Classes

Sub:Strength of Material (22306)

UNIT 3. Mechanical Properties and Elastic constants

3.1 Types of Loads and related deformation, Flexure,Torsion,Shear .

3.2 Mechanical properties : Elasticity,Plasticity,Ductility,Brittleness, Malleability,Fatigue, Creep, Toughness and Hardness.

3.3 Strength, Factor of safety, Stiffness and flexibility.

3.4 Linear and lateral strain, Poisson's ratio, Change in lateral dimensions

3.5 Uni-Bi-Tri axial stress systems, Strain in each direction, Bulk modulus,Volumetric strain

3.6 Relation between three modulli.

3.7 Stress due to gradual, sudden and impact load, corresponding deformation. Energy, resilience, Proof resilience and modulus of resilience.

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Websites : www.msbte.engg-info.website, www.mechdiploma.com,

Type 1. Problems on 3 moduli of elasticity.

1. A material has Young's Modulus of 2.1 $\times 10^5$ 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 $\times 10^5$ N/mm2 and Bulk modulus 1.2$\times 10^5$ N/mm^2 .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 $\times 10^5$ 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 2. Problems on Poissons 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 and following observations were noted 1)Gauge length : 200mm 2) Load on Proportional limit :20kN 3)Change in length : 0.2 mm 4) Change in dia : 0.0025 mm. Determine E,G,K and u.

(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 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 u=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 Young's Modulus and Poisson's ratio.

(Ans: E= 150×103 n/mm2 , m=2)

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9. For a metal bar of 20 mm diameter and 1m long is subjected to an axial pull of 60 KN Take $E = 1.8 \times 10^5 N/mm^2$ ***and .Find the change in the diameter of the bar.***

Type 3: Problems on Bi-axial and Tri-axial stress system.

1. In a biaxial stress system the stresses along x direction is 60 N/mm2 tensile and along y direction 40 N/mm2 compressive .Find the maximum strain. Take E = 200Gpa and poisons ratio =0.25

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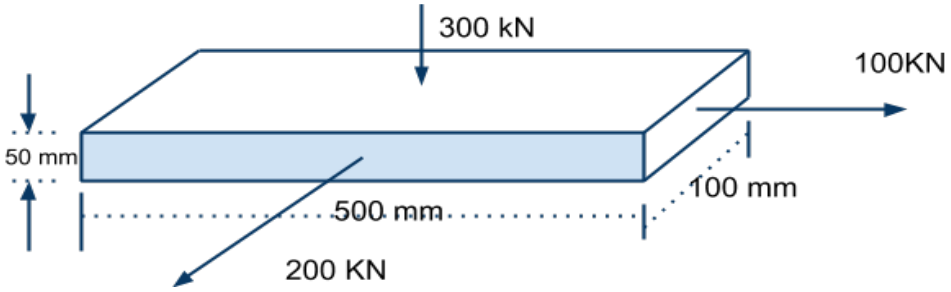
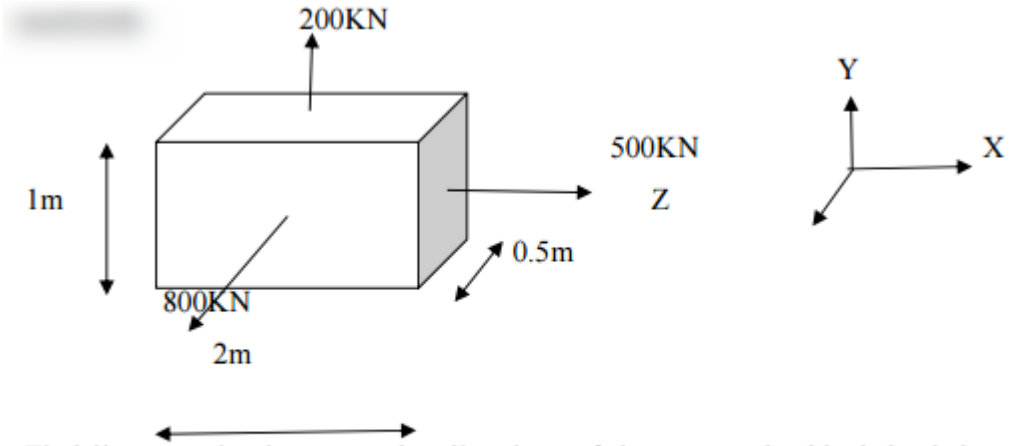
2. A rectangular bar 500mm long and 100 mm by 50mm in cross-section is subjected to forces as shown below.



What is the change in the volume of the bar? take modulus of elasticity of 200GPa and poisson's ratio as 0.25.

(Ans: dv= 137.5 mm3)

3.



Find linear strains in x, y and z directions of the rectangular block loaded as shown in the figure. Hence using the linear strains values , find the total strain in z direction. Take E= 200GPa. and Poisson's ratio= 0.25

4.A steel cube block of 50 mm side is subjected to a force of 6kN(tension), 8 kN(compression) and 4 kN(tension) along x, y and z direction respectively. Determine the change in volume of the block. Take E as 200 Gpa and m as 10/3.

{dv=0.2 m^3}

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5. A steel bar 1.2 m long,50mm wide and 40 mm thick is subjected to an axial pull of 150 kN in the direction of its length. Determine the change in volume of the bar. Take E=200 GPa,m=4

(Ans:450 mm3)

6.A steel cube block of 100 mm side is subjected to a stress of 50 N/mm2 (tensile) in x direction, a stress of 40 N/mm2 (compressive) in y direction, a stress of 30 N/mm2 (tensile) in z direction, calculate strain in each direction and dv. E=200 Gpa, and Poisson ratio =0.25

(Ans:dv=100 mm3)

7.In a tri-axial stress system the stresses along the three directions are 100 N/mm2 (tensile) in x direction, 60 N/mm2 (tensile) in y direction, 30N/mm2 (comp) in z direction, calculate strain in each direction and change in volume take E=200Gpa and Poisson ratio as 0.25 take x=400,y=150,z=300

(ans dv= 5850 mm3)

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8. A cube of 100 mm side is subjected to a tensile force of 200 kN on all faces (tensile). Find the strains in each direction. Also find the change in volume of the cube.

(ans dv=150mm3)

Type 4: Problems on Strain Energy

1) Calculate the strain energy stored in a bar 50mm diameter & 2.5 m long subjected to tensile load of 100kN take $2\times10^5 N/mm^2$ ***if***

1) load is gradually applied

2) load is suddenly applied

{u = 31.81 x 10 3 N –mm,u = 127.28 x 10 3 N –mm}

2.A square steel rod 50 mm size & 3 m long is subjected to a pull of 100kN suddenly applied to it Calculate,

i) Strain

ii) Elongation

iii) Modulus of resilience E = 210 Gpa.

{u = 1.14 x 10^6 N–mm,δ l =1.14 mm, u = 0.0152 N–mm/mm 3}

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3) A bar 1.5 m long10 mm diameter hangs vertically , it has a collar fixed at lower end .a load of 120 N falls on the collar from the height of 30 mm. Calculate strain energy absorbed .Youngs modulus for material is $2\times10^5 N/mm^2$.

{σ =112.09 N / mm 2,u =3.7 X 10^3 N –mm}

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4)A steel bar 20 mm is 7 m long & has collar attached to it .A load of 800N falls on it from a height of 60 mm. Find -

1] Stress 2] Change in length. 3] Strain energy 4] modulus of resilience.

Youngs modulus for material is $2\times10^5 N/mm^2$.

{σ=96.01 N / mm 2,δl=3.36 mm, U=50.47 x 10 N –mm, U =0.023 N / mm2}

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5) A bar 30 mm x 30 mm is 4.5 m long is subjected to impact load of 300 N which falls on collar from a height of 400 mm. Find 1] Stress 2] Strain energy 3]Change in length. 4] mod. of resilience .

{σ =109.20 N/mm^2,μ=120.74 x 10 N –mm,δl=2.457 mm,U =0.029 N /mm^2}

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6)An unknown weight falls by 30 mm on to a collar rigidly fixed to lower end of vertical bar 4 m long & 1000mm 2 in area. If instantaneous elongation is 3.66 mm. Determine –1] The stress produced 2] Unknown weight. E= $2\times10^5 N/mm^2$

{σ=183 N/mm2,P=9.94x10^3 N}

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7)An unknown weight falls through a height of 12mm on to a collar . Attached to the bottom of bar 2.5 m long & 100 mm 2 in area if maximum instantaneous elongation is 1.6 mm. Find 1] Stress 2]Unknown weight. E = 200 Gpa.

{σ=128 N / mm2,P=752.94 N}