Mechanics of Materials I:

Fundamentals of Stress & Strain and Axial Loading

Dr. Wayne Whiteman
Senior Academic Professional and Director of the Office of Student Services
Woodruff School of Mechanical Engineering

Georgia Institute of Technology

Module 13 Learning Outcomes

- Define and Calculate Poisson's Ratio
- Define Homogeneous Materials
- Define Isotropic Materials

Poisson's Ratio (for uniaxial stress/strain)

Lateral Strain: $\varepsilon' = \frac{\delta_{Lateral}}{w_O}$

Longitudinal Strain: $\varepsilon = \frac{\delta_{Longitudinal}}{L_O}$

Poisson's ratio:

$$\upsilon = -\frac{\varepsilon'}{\varepsilon}$$

Assumes:

Homogeneous:
Same material throughout

Istotropic:
Same material properties in all directions

Lateral Strain: $\varepsilon' = \frac{\delta_{Lateral}}{w_O}$

Longitudinal Strain: $\varepsilon = \frac{\delta_{Longitudinal}}{L_O}$

Poisson's ratio:

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Example:

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A structural member of the GT CRC is tested. It is made out of a rectangular steel alloy. The length is 2 meters. The cross section is 25 mm by 50 mm. It is subjected to a tensile force of 40 kN. The test section elongates 2 mm. The width narrows by 0.014 mm (the new width is 49.986 mm).

a) Find Poisson's ratio.

b) What is the new height of the cross section?

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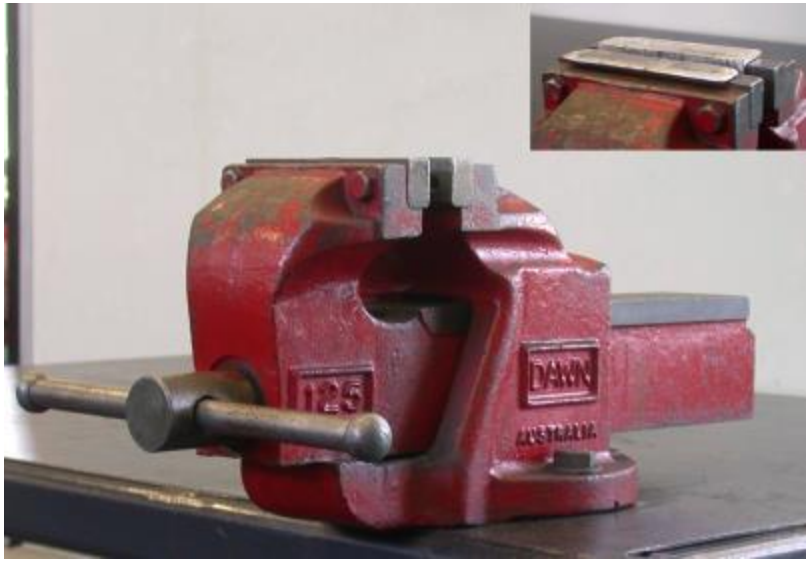
Worksheet:



Worksheet:

A section of magnesium alloy is being tested. It is subjected to a 12 kN compression force. The length is 50 mm. The cross section is 10 mm by 10 mm. The longitudinal strain is 0.0015. Poisson's ratio for the material is 0.35.

a) Find the average normal stress at the instant when the load is applied.

b) Find the height and width of the cross section after compression.

Lateral Strain: $$\varepsilon' = \frac{\delta_{Lateral}}{w_O}$$

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a) Find the average normal stress at the instant when the load is applied.

b) Find $\delta_{Longitudinal}$

c) Find the height and width of the cross section after compression.

Lateral Strain: $\varepsilon' = \dfrac{\delta_{Lateral}}{w_o}$

Longitudinal Strain: $\varepsilon = \dfrac{\delta_{Longitudinal}}{L_o}$

Poisson's ratio: $\upsilon = -\dfrac{\varepsilon'}{\varepsilon}$

a) $\sigma = P/A = \dfrac{12\ KN}{(10mm)(10mm)} = 0.12\ KN/mm^2 = \underline{\underline{120\ MPa}}$ ANS.

b) $\delta_{LONGITUDINAL} = -\epsilon L_o = -0.0015\,(50\ mm) = \underline{\underline{-0.075\ mm}}$ ANS [NEGATIVE BECAUSE OF COMPRESSION]

c) $\nu = -\dfrac{\epsilon'}{\epsilon}$

$0.35 = -\dfrac{\epsilon'}{(-0.0015)}$

$\epsilon' = 0.000525 = \dfrac{\delta_{LATERAL}}{w_o} = \dfrac{\delta_{LATERAL}}{10\ mm}$

$\delta_{LATERAL} = 0.00525mm$

NEW HEIGHT AND WIDTH $= 10mm + 0.00525\ mm = \underline{\underline{10.00525\ mm}}$ ANS