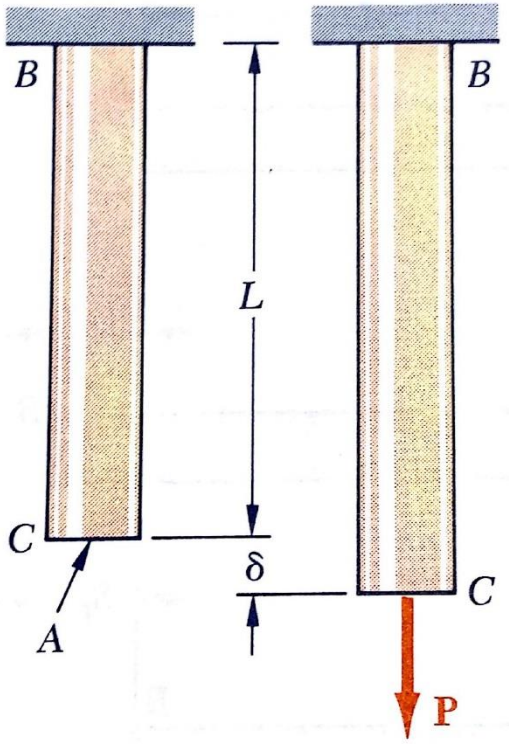
Elasticity exercises

A rod of length L=500 mm and cross-sectional area A=60 mm2 is made of an elastoplastic material having a modulus of elasticity E= 200 GPa in its elastic range and a yield point σ_Y= 300 MPa. The rod is subjected to an axial load until it is stretched 7 mm and the load is removed. What is the resulting permanent set?

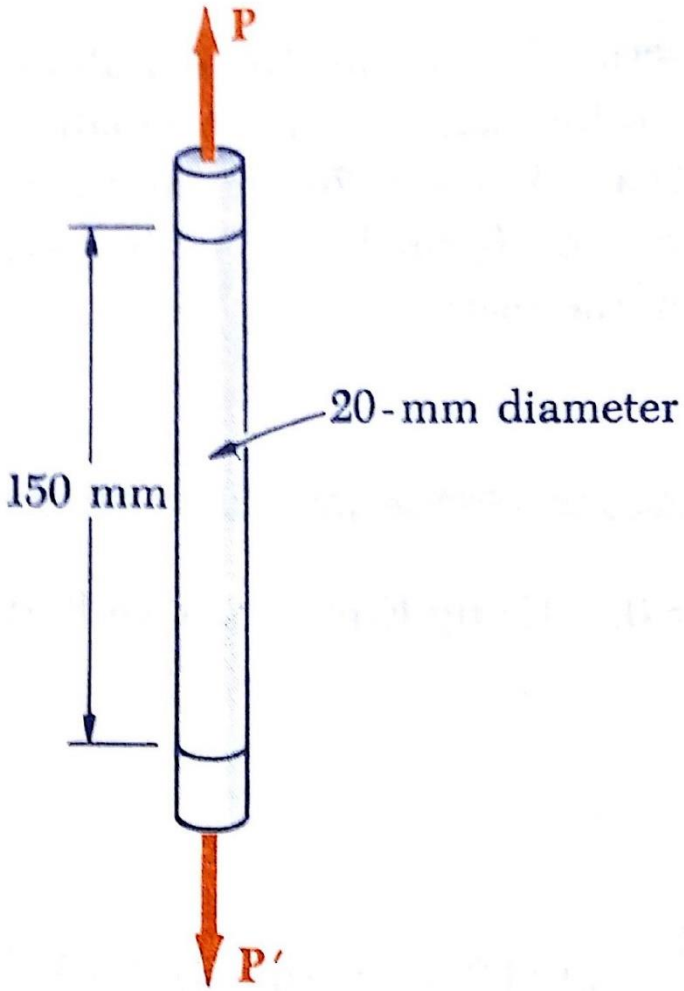
A rod made of an elastoplastic material has a modulus of elasticity E= 200 GPa and a yield point σ_Y= 300 MPa. The rod is subjected to a multiaxial stress state of the following magnitudes. Decide if the material yields.

$$\sigma = \begin{bmatrix} 100 & 120 & 60 \\ 100 & 150 & 110 \\ 80 & 60 & 50 \end{bmatrix}$$

The cylindrical rod AB has a length L= 2m and a 32mm diameter. It is made of a mild steel which is elastoplastic with E= 200 GPa and σ_Y= 250 MPa. A force P is applied to the rod until its end A has moved down relative to the its top side that is connected to a support. What is the maximum value of the force P and the permanent set of the rod after the force has been removed if the elongation is a) 3mm, b) 6mm?



In a standard tensile test an aluminum rod of 20 mm diameter is subjected to a tensile force of magnitude P= 30 kN. What is the a) elongation of the rod in a 150 mm gage length and b) change in diameter of the rod if E= 70 GPa and υ= 0.35. Also consider c) the dilatation (the change in volume) of the rod.

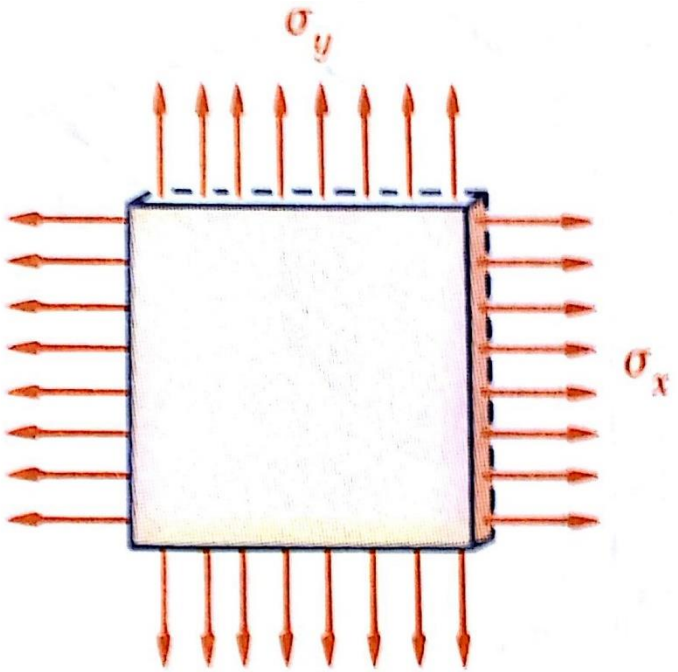


In many situations it is known that the normal stress in a given direction is zero in the case of a thin plate that is under plane stress condition. Show that the following expressions for stresses and strain are correct for the strains in the x and y directions that are determined experimentally.

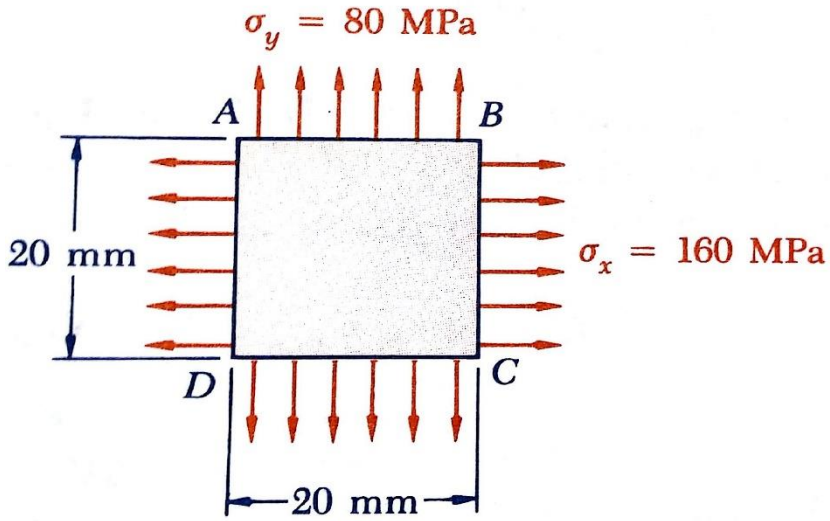
$$\sigma_x = E\frac{\epsilon_x + \upsilon\epsilon_y}{1-\upsilon^2}$$

$$\sigma_y = E\frac{\epsilon_y + \upsilon\epsilon_x}{1-\upsilon^2}$$

$$\epsilon_z = -\frac{\upsilon}{1-\upsilon}(\epsilon_x + \epsilon_y)$$



A 20 mm square was scribed on the side of a large steel pressure vessel. The plane stress condition of the material after pressurization is shown. What is the change in the lengths of the sides if E= 200 GPa and υ= 0.3 ? Is this change purely elastic or does yielding occur if the yield stress is 120 MPa?



A circle of diameter d= 200 mm is scribed on an unstressed cast iron plate of thickness t= 18 mm. Forces acting in the plane of the plate later cause normal stresses σ_x= 85 MPa and σ_z= 150 MPa. What are the changes in a) the length of diameter AB, b) the length of diameter CD, c) the thickness of the plate if E= 70 GPa and υ=1/3? Are these changes purely elastic? Yield strength is 150 MPa.