Answer on Question#50402 - Physics - Mechanics - Kinematics - Dynamics

A bar of circular cross-section is loaded by a compressive force $P = 100\,\text{kN}$. The bar has length $L = 2.0\,\text{m}$ and diameter $d = 30\,\text{mm}$. It is made of aluminum alloy with modulus of elasticity $E = 73\,\text{GPa}$. What is the strain of the bar? Express the answer in mm/m.

Solution:

The stress of cylinder is given by the Hooke's law

$$\sigma = E\varepsilon,$$

where $\sigma = \frac{P}{A}$ is a stress (F is the compressive force acting on the bar, and A is the cross-sectional area of the bar), E is the modulus of elasticity, and ε is the strain of the cylinder.

The cross-sectional area of the bar is given by

$$A = \frac{\pi}{4}d^2$$

The stress of the cylinder

$$\sigma = \frac{P}{A} = \frac{4P}{\pi \cdot d^2}$$

The strain of the cylinder

$$\varepsilon = \frac{\sigma}{E} = \frac{4P}{\pi \cdot E \cdot d^2} = \frac{100\,\text{kN}}{\pi \cdot 73\,\text{GPa} \cdot (0.03)^2\,\text{m}^2} = 4.8 \cdot 10^{-4} = 0.48\frac{\text{mm}}{\text{m}}$$

Answer: $\varepsilon = \frac{4P}{\pi \cdot E \cdot d^2} = 0.48\frac{\text{mm}}{\text{m}}$.