

A structural steel rod has a radius of 10 mm and a length of 1.0 m. A 100 kN force stretches it along its length. Calculate (a) stress, (b) elongation, and strain on the rod. Young's modulus, of structural steel is $2.0 \times 10^{11} \text{ N m}^{-2}$.

$$\text{Strain} = \frac{\Delta L}{L} = \frac{1.59 \times 10^{-3}}{1.59 \times 10^{-3}}$$

$$\begin{aligned} \text{Stress} &= \frac{F}{A} \\ &= \frac{100 \times 10^3}{\pi r^2} \\ &= \frac{10^5}{3.14 \times (10^{-2})^2} \\ &= 3.18 \times 10^8 \text{ N/m}^2 \end{aligned}$$

$$\begin{aligned} y &= \frac{F/A}{\frac{\Delta L}{L}} \Rightarrow \Delta L = \frac{(F/A)L}{y} \\ &= \frac{3.18 \times 10^8 \times 1}{2 \times 10^{11}} = 1.59 \times 10^{-3} \text{ m} \end{aligned}$$