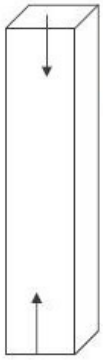
GPH 201 – (Q & A - Unit 1)

Example (text problem 10.1): A steel beam is placed vertically in the basement of a building to keep the floor above from sagging. The load on the beam is 5.8×10^4 N and the length of the beam is 2.5 m, and the cross-sectional area of the beam is 7.5×10^{-3} m^2. Find the vertical compression of the beam.



$$\frac{F}{A} = Y\frac{\Delta L}{L}$$

$$\Delta L = \left(\frac{F}{A}\right)\left(\frac{L}{Y}\right)$$

For steel $Y=200\times10^9$ Pa.

$$\Delta L = \left(\frac{F}{A}\right)\left(\frac{L}{Y}\right) = \left(\frac{5.8\times10^4\ \text{N}}{7.5\times10^{-3}\ \text{m}^2}\right)\left(\frac{2.5\ \text{m}}{200\times10^9\ \text{N/m}^2}\right) = 1.0\times10^{-4}\ \text{m}$$

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Example (text problem 10.6): A 0.50 m long guitar string, of cross- sectional area 1.0×10^{-6} m^2, has a Young's modulus of 2.0×10^{9} Pa. By how much must you stretch a guitar string to obtain a tension of 20.0 N?

$$\frac{F}{A} = Y\frac{\Delta L}{L}$$

$$\Delta L = \left(\frac{F}{A}\right)\left(\frac{L}{Y}\right) = \left(\frac{20.0\ \text{N}}{1.0\times10^{-6}\ \text{m}^2}\right)\left(\frac{0.5\ \text{m}}{2.0\times10^{9}\ \text{N/m}^2}\right)$$

$$= 5.0\times10^{-3}\ \text{m} = 5.0\ \text{mm}$$

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Example (text problem 10.24): An anchor, made of cast iron of bulk modulus 60.0×10^9 Pa and a volume of 0.230 m^3, is lowered over the side of a ship to the bottom of the harbor where the pressure is greater than sea level pressure by 1.75×10^6 Pa. Find the change in the volume of the anchor.

$$\Delta P = -B\frac{\Delta V}{V}$$

$$\Delta V = -\frac{V\Delta P}{B} = -\frac{(0.23\ \text{m}^3)(1.75\times10^6\ \text{Pa})}{60.0\times10^9\ \text{Pa}}$$

$$= -6.7\times10^{-6}\ \text{m}^3$$