Answer on Question #41324, Engineering, Other

At a building site, an iron girder of mass 400 kg is suspended from a crane by a steel cable. Assume that the cable has a circular cross-section of diameter 24 mm.

a. What is the tensile force in newtons on the cable given that force = mass × g (where the acceleration due to gravity, g = 9.8 m s^{-2}). Ignore the mass of the cable.

(2 marks)

Solution:

$$F = mg = 400 * 9.8 = 3920 \text{ N}$$

Answer: 3920 N

b. Calculate the cross-sectional area of the cable in square metres.

(3 marks)

Solution:

For single-strand cable use the following formula to calculate the exact area of the cable where the diameter of the cable-strand is known:

$$s = \pi\left(\frac{D}{2}\right)^2$$

Where:

s = area of a single strand

D = diameter of a single strand

π = 3.14

$$s = 3.14 * \left(\frac{24 * 10^{-3}}{2}\right)^2 = 0.0004524 = 4.52 * 10^{-4} \text{ m}^2$$

Answer: $4.52 * 10^{-4} \text{ m}^2$

c. Show that the stress on the cable is 8.67 × 10^6 N m^{-2}. Again ignore the mass of the cable.

(3 marks)

Solution:

The stress is

$$\sigma = \frac{F}{s}$$

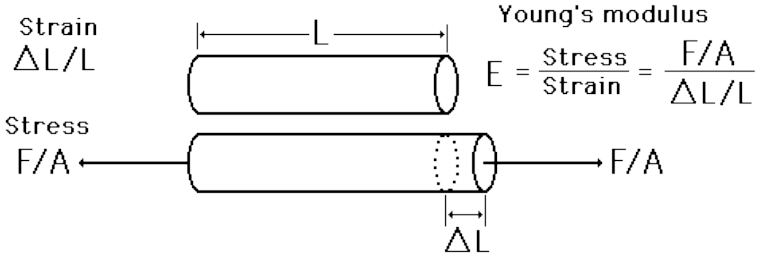
where F = 3920 N is force, and $s = \frac{\pi d^2}{4}$ is the cross-section of the cable.

$$\sigma = \frac{3920}{4.52 * 10^{-4}} = 8.67 * 10^6 \text{ N} \cdot \text{m}^{-2}.$$

Answer: $8.67 * 10^6 \text{ N} \cdot \text{m}^{-2}$

d.If the Young's modulus of the steel cable is 200×10^9 N m^{-2}, calculate the strain in the cable.
(3 marks)

Solution:



Thus,

$$Strain = \frac{Stress}{E} = \frac{8.67 * 10^6}{200 * 10^9} = 0.00004335 = 43.35 * 10^{-6}$$

Answer: $43.35 * 10^{-6}$

e.When it is loaded with the iron girder, the steel cable stretches by 0.78 mm. Calculate what the original length of the steel cable was (i.e. its length prior to loading).
(4 marks)

Solution:

$$Strain = \frac{\Delta L}{L}$$

Thus,

$$L = \frac{\Delta L}{Strain} = \frac{0.78 * 10^{-3}}{43.35 * 10^{-6}} = 18 \text{ m}$$

Answer: 18 m.