Answer on Question#37777, Engineering, Other

Question:

A 4 m long steel wire having 40 mm in diameter, a Young`s modulus of $20 \times 10^{10}\ N/m^2$ and an elastic limit of $2.5 \times 10^8\ N/m^2$ is used to support a weight of 100 kN.

a) By how much does the wire stretch under this load?

b) What is the maximum weight the steel wire is able to support without being permanently deformed?

Answer:

a) Hooke's law can be expressed in equation form as follows:

$$\frac{F}{A} = E\frac{\Delta l}{l}$$

where E is Young`s modulus, A - cross section, l – length, F – force, Δl is stretch.

In our case force equals weight: $F = P = 100\ kN$.

Therefore, stretch of the wire equals:

$$\Delta l = \frac{P}{\pi d^2/4}\frac{l}{E} \cong 0.0016\ m = 1.6\ mm$$

Answer: $1.6\ mm$

b) Elastic limit is the greatest stress that can be applied to a material without causing permanent deformation. Assuming stress σ by definition equals $\frac{F}{A}$, maximum force (weight) equals:

$$P_{max} = \sigma_{max} * A \cong 310\ kN$$

Answer: $310\ kN$