Answer on Question #76024 - Physics / Mechanics | Relativity

A rigidly fixed strut in a refrigeration system carries a compressive load of 50 KN when assembled at a temperature of 20 degree Celsius. The initial length of the strut is 1.25 m and its diameter is 30 mm. Determine the initial stress in the strut and the amount of compression load and the factor of safety if the ultimate compressive stress of the material is 350 MPa. Take E=150 GN/sq-m and α (Alpha) = 16 X 10 -6 /°C.

Solution: finding cross-sectional area: $A=\frac{\pi \times d^2}{4} = \frac{3.14 \times 0.03^2}{4} = 7.1 \times 10^{-4}\ m^2$.

Now we find initial stress at 20 degree Celsius: $\sigma_D = \frac{F}{A} = \frac{50000}{7.1 \times 10^{-4}} = 70.4 \times 10^6\ Pa$, or 70.4MPa.

Calculate the value of compression under load: $\varepsilon=\frac{\Delta l}{l} = \frac{\frac{Fl}{EA}+l\alpha t}{l} = \frac{\frac{50000 \times 1.25}{106500000}+0.0004}{1.25} = 0.0008$.

The safety factor will be calculated as the ratio of the maximum load to the estimated load, then:

$SF=\frac{350}{\sigma_D + E\alpha t} = \frac{350}{70.4-48} = 16.2$

Answer: σ_D=70.4MPa; ε=0.0008; SF=16.2.