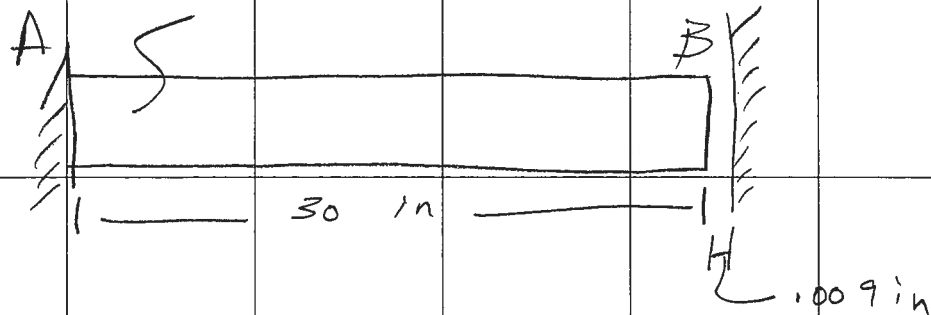


A copper bar has an initial length of 30 in and is supported as shown. The left end is fixed and there is a gap of 0.009 in. at the right end. Calculate the compressive stress in the member if the temperature increases by 50°F . Assume $E_c = 16 \times 10^6 \text{ psi}$ and $\alpha_c = 9.6 \times 10^{-6} / ^{\circ}\text{F}$.

$$A_0 = 2 \text{ in}^2$$



First remove the constraint at B and allow the bar to elongate freely. In this case the elongation of the bar, δ'_{AB} , will be given as follows

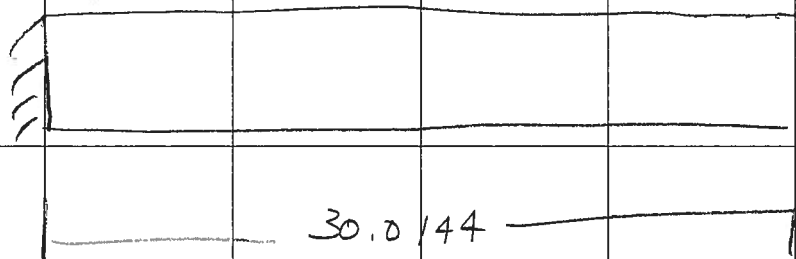
$$\delta'_{AB} = \alpha \Delta T L$$

(1)

$$\delta_{AB}' = (9.6 \times 10^{-6} / ^\circ F)(50^\circ F)(30 \text{ in.}) \quad (2)$$

$$\delta_{AB}' = .01440 \text{ in.} \quad (3)$$

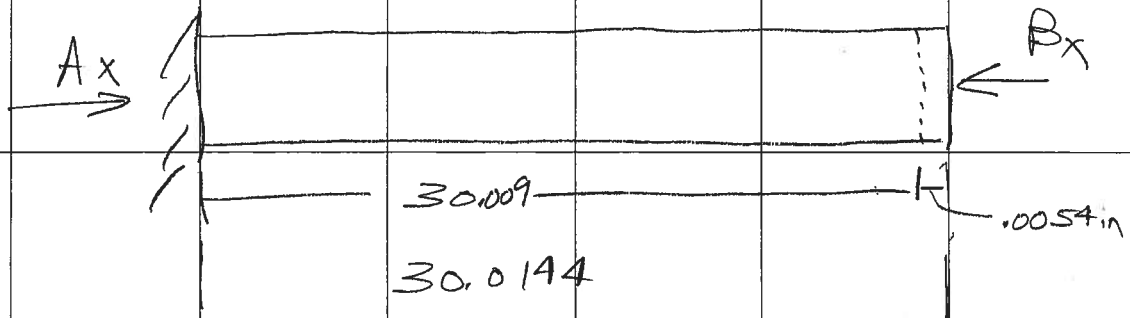
Thus, the bar elongates to a length of 30.0144 in. as shown



However the constraint at B prevents the length of the bar from exceeding 30.009 in.

Thus it can be seen that the reaction at B must make up the difference by causing a compressive deformation of
 $.0144 - .009 = .0054 \text{ in}$

as shown below:



The deformation of the bar
due to the compressive force B_x
is

$$\delta_{AB}'' = 0.0054 \text{ in} = \frac{B_x L_{AB}}{A_{AB} E_{AB}} \quad (4)$$

$$0.0054 \text{ in} = \frac{B_x (30 \text{ in})}{(2 \text{ in}^2) (16 \times 10^6 \frac{\text{lb}}{\text{in}^2})} \quad (5)$$

$$B_x = 5760 \text{ lb} \quad (6)$$

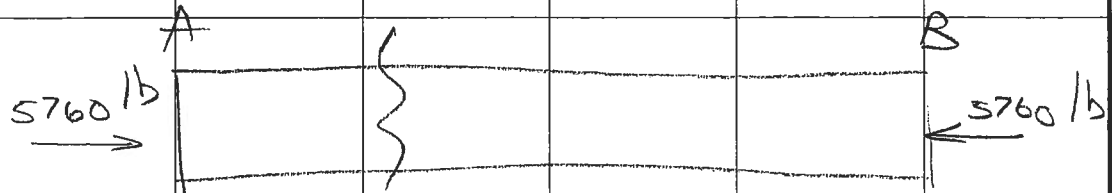
Then by equilibrium

$$\rightarrow \sum F_x = 0$$

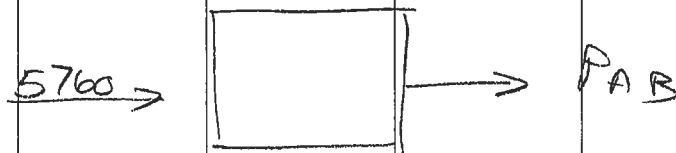
$$A_x - B_x = 0 \quad (7)$$

$$A_x = B_x = 5760 \text{ lb} \quad (8)$$

So a F.B.D of the bar
is given as follows



The internal force in section
AB is found using a F.B.D
as follows



$$\rightarrow \sum F_x = 0$$

$$5760 + P_{AB} = 0$$

(9)

$$P_{AB} = -5760 \text{ lb} \quad (10)$$

or

5760 lb compression

The corresponding compressive
stress is

$$\sigma_{AB} = \frac{P_{AB}}{A_{AB}}$$

(11)

$$\nabla_{AB} = \frac{-5760 \text{ lbs}}{2 \text{ in}^2}$$

(12)

$$\nabla_{AB} = -2880 \frac{\text{lb}}{\text{in}^2}$$

(13)