Exercise No. 1 10 pts.

The horizontal rigid bar ABCD is supported by the vertical bars BE and CF and is loaded by vertical forces $P_1 = 5 \text{kN}$ and $P_2 = 10 \text{kN}$ acting at points D and A, respectively. Bars BE and CF are made of steel ($E = 210 \text{ GPa}$) and have cross sectional areas: $A_{BE} = 450 \text{ mm}^2$ and $A_{CF} = 650 \text{ mm}^2$.

Determine the vertical displacements $\delta_D$ and $\delta_A$ of points D and A, respectively.

\[ \delta_B = \frac{B \cdot 0.7}{210 \cdot 10^9 \text{N/m}^2 \cdot 150 \cdot 10^{-6} \text{ m}^2} \]

\[ \delta_B = \frac{15,000 \cdot 0.7}{210 \cdot 10^9 \cdot 450 \cdot 10^{-6}} = 0.0001 \text{ m} = 0.1 \text{ mm} \]

\[ \delta_D = \delta_B = -0.2 \text{ mm} \text{ (downward)} \]

\[ \delta_A = \frac{\delta_B \cdot 1 \text{ m} = 0.1 \text{ mm}}{0.5} \]

\[ \delta_A = \frac{0.1 \text{ mm}}{0.5} = 0.02 \text{ mm} \text{ (upward)} \]
Exercise No. 2  5 pts

At room temperature (70°F) a 0.02in. gap exists between the ends of the rods shown. At a later time when the temperature has reached 320°F, determine: a) the normal stress in the aluminum rod; and b) Determine the change in length of the aluminum rod.

Aluminum

\[ A = 2.8 \text{ in}^2 \]
\[ E = 10.4 \times 10^6 \text{ psi} \]
\[ \alpha = 13.3 \times 10^{-6}/\text{°F} \]

\[ \delta = 0.02 \text{ in.} \]

10 in. 10 in.

Stainless steel

\[ A = 1.2 \text{ in}^2 \]
\[ E = 28.0 \times 10^6 \text{ psi} \]
\[ \alpha = 9.6 \times 10^{-6}/\text{°F} \]

\[ \delta_{\text{AT}} \]  

\[ \delta_{\text{ST}} = \alpha_{\text{S}} \Delta T \times L_S = 9.6 \times 10^{-6} \times 250 \times 10 \text{ in} \]

\[ \delta_{\text{ST}} = 0.02 \text{ in} \]

\[ \delta_{\text{AS}} = \frac{R_A \times L_A}{E_A \times A_A} \]

\[ \delta_{\text{AS}} \]

\[ \delta_{\text{SS}} = \frac{R_S \times L_S}{E_S \times A_S} \]

\[ R_A = R_S \]

\[ \delta = \delta_{\text{AT}} + \delta_{\text{AS}} + \delta_{\text{ST}} + \delta_{\text{SS}} \]

\[ \delta_{\text{AT}} - \delta_{\text{AS}} + \delta_{\text{ST}} = \delta_{\text{SS}} = \delta \]

\[ \delta_{\text{AT}} + \delta_{\text{ST}} = R_A \left( \frac{L_A}{E_A A_A} + \frac{L_S}{E_S A_S} \right) = \delta \]

\[ R_A = \frac{\delta_{\text{AT}} + \delta_{\text{ST}} - \delta}{\left( \frac{L_A}{E_A A_A} + \frac{L_S}{E_S A_S} \right)} = \frac{0.0325 + 0.024 - 0.02}{\frac{10}{10.4 \times 10^6} + \frac{10}{2.8 \times 10^6 \times 1.2}} \text{ lbs} \]
a) \[ R_A = 58,110 \text{ lbs} = R_B \]

b) \[ \sigma_A = \frac{R_A}{A_P} = \frac{58,110}{2.8} = 20,753 \text{ ksi} \]

\[ \delta_A = \delta_{AT} - \delta_{AS} \]

\[ \delta_A = 0.03325 \text{ in} - \frac{58,110 \times 10}{2.8 \times 10^8} \]

\[ \delta_A = 0.0139 \text{ in} \]