Problem 1: Determine (a) change in length in inches and (b) force in member AB.

**Given:** Strain, \( \varepsilon = 8.9 \times 10^{-4} \). Member is an L3 x 2 1/2 x 1/4 of A36 steel.

**Solution:**

1) Calculate length, \( L \), of AB

\[
\Delta L = \sqrt{108^2 + 168^2} = 208.7351''
\]

2) Calculate \( \Delta L \)

\[
\varepsilon = \frac{\Delta L}{L} \rightarrow \Delta L = \varepsilon L = (8.9 \times 10^{-4}) (208.7351'') = \Delta L = 0.136''
\]

3) Calculate \( \sigma \)

\[
E = \frac{\sigma}{\varepsilon} \rightarrow E \varepsilon = \sigma \Rightarrow \sigma = (29,000 \text{ kpsi}) (8.9 \times 10^{-4}) = 25.81 \text{ kpsi}
\]

4) Calculate beam AB area

area = 1.32 \text{ in}^2 \quad * \text{Obtained from Manual Table 1-7 Pg. 1-46}

5) Calculate force in beam AB

\[
\sigma = \frac{P}{A} \rightarrow \sigma A = P = (25.81 \text{ kpsi}) (1.32 \text{ in}^2) = \text{Force} = 33.88 \text{ k}
\]
Problem: Compute the normal stress at Point A and Point B, clearly indicating whether the stress is compressive or tensile.

Given: Dimensions are given in the figure as well as the direction of the 500 lb force applied and the locations of A and B.

Solution:
Using cut at A-B to solve for P, M, V.

\[ O = \sum F_y = -\frac{4}{3} (500\text{lb}) + P \Rightarrow P = 400\text{lb} \]
\[ O = -\sum F_x = \frac{2}{3} (500\text{lb}) - V \Rightarrow V = 300\text{lb} \]
\[ O = \sum M = -8\text{ft} (300\text{lb}) - 5\text{ft} (400\text{lb}) + M \Rightarrow M = 4,400 \text{lb-ft} \times \frac{12\text{in}}{1\text{ft}} \Rightarrow M = 52,800\text{lb-in} \]

Calculate moment of inertia \( I_y \)

\[ I_y = I_{zh} + A y^2 = \left[ \frac{1}{12} (3)(0.5)^3 + (3)(0.5)(1.75)^2 \right] + \frac{1}{12} (0.5)(0.3)^3 = 10.375\text{in}^4 \]

Solve for stress, \( \sigma = \frac{P}{A} + \frac{Mc}{I_{zh}} \)

For both A, B the normal stress is compressive, for A, the bending stress is tensile, and for B the bending stress is compressive.

\[ \sigma_A = -\frac{1000\text{lb}}{3.5\text{in}^2} + \frac{52,800 \times 2}{10.375} = 10,100\text{ psi} \Rightarrow \sigma_A = 10,100\text{ psi, tensile} \]
\[ \sigma_B = -\frac{1000\text{lb}}{3.5\text{in}^2} - \frac{52,800 \times 2}{10.375} = -10,800\text{ psi} \Rightarrow \sigma_B = -10,800\text{ psi, compressive} \]
3. **GIVEN** The angle bracket is subjected to \( P = 1300 \text{ lb} \). It has a rectangular x-section with a width of \( b = 3.00'' \) and a thickness \( t = 0.375'' \).

**FIND** Max \( y \) can be used if the tensile normal stress must be limited to 24000 psi at Section \( a-a \).

**SOLUTION**

\[
0 = \sum F_x = 1300 \text{lb} - P
\]

\[
P = 1300 \text{lb}
\]

\[
0 = \sqrt{1} \sum M_a = M = (1300)(y + \frac{t}{2})
\]

\[
M = 1300(y + 0.1875)
\]

\[
A = (3.00')(0.375') = 1.125 \text{in}^2
\]

\[
I = \frac{1}{12} (3.00')(0.375')^3 = 0.01318 \text{in}^4
\]

\[
\sigma_{\text{max}} = \frac{P}{A} + \frac{Mc}{I}
\]

\[
\sigma_{\text{max}} = \frac{1300}{1.125} + \frac{1300(y + 0.1875) \times 0.1875}{0.01318} = 24000 \text{psi}
\]

\[
y_{\text{max}} = 1.05 \text{in}
\]
4. GIVEN

1" diameter punch punches through steel plates that fail at a shear stress of 40 ksi. It's made of cast iron which will fail if either tensile stress > 10 ksi or compressive stress > 25 ksi @ a-a

FIND thickness of steel plate that the punching device can handle.

SOLUTION

\[
T = \frac{P}{A} = \frac{P}{\pi \times 1" \times d} = 40 \text{ ksi}
\]

\[
\frac{P}{d} = 125.66 \text{ (ksi x in)}
\]

\[
d = \frac{P}{125.66}
\]

\[
0 = M_a = M_a = P(20+y) - Pa
\]

\[
M_a = (20+y)Pa
\]

\[
y = \frac{(20/2)(1) + (6)(1/2)(5/2)}{(2 \times 7/2) + (2 \times 6)(1/2)} = 3"\]

\[
y = \frac{(7/2)(2) + (2)(7/2)(2)}{2 \times 7/2 + (2)(6)(1/2)} = 3"
\]

\[
I_y = \frac{1}{2} \left[ \left( \frac{7}{2} \right)(2)^2 + (2)(7/2)(2)^2 + \left( \frac{3}{2} \right)(6)(1/2) + (6)(1/2)(2)^2 \right] = 170 \text{ in}^4
\]

\[
T = \frac{P}{A} + \frac{MC}{I}
\]

\[
A = \left( \frac{7}{2} \right)(2) + (2 \times 1/2)(6) = 30 \text{ in}^2
\]

\[
\begin{align*}
\sigma_T &= \frac{P}{30 \text{ in}^2} + \frac{25P(3)}{170 \text{ in}^4} = 10 \text{ ksi} \\
P &= 22.77 \text{ kip}
\end{align*}
\]
\[
\sigma_1 = \frac{22.77}{125.66} \text{ in} = 0.181 \text{ in} \\
T_c = \frac{P}{30 \text{ in}^2} - \frac{23P(5)}{170 \text{ in}^4} = -25 \text{ ksi} \\
P = 38.87 \text{ kip} \\
\sigma_2 = \frac{38.87}{125.66} \text{ in} = 0.309 \text{ in} \\
\therefore \sigma_1 < \sigma_2 \\
To \ ensure \ all \ the \ limiting \ conditions
\]
\[
d_{\text{max}} = 0.181 \text{ in} 
\]