1. Draw the shear and moment diagrams for the beam shown below.

\[ \Sigma F_y = -400(10) - 6000 + Ay + By = 0 \]

\[ \Sigma M_A = -400(10)(5) - 6000(15) + By(20) \]

\[ By = 5500 \text{ lb} \]

\[ Ay = 4500 \text{ lb} \]
2. A beam has the "T" cross-section shown below. This cross-section is subjected to a bending moment $M = 5000$ in-lb that causes compressive normal stresses above the neutral axis. In addition, the cross-section is subject to a 3000 lb tensile axial force. Calculate the maximum tensile stress acting on points within this cross-section.

\[ \sigma_{\text{max}} = \frac{M \cdot y}{I_{\text{NA}}} = \frac{5000 \text{in-lb} \cdot (1.625\text{in})}{1.135\text{in}^4} = 7159 \text{ psi} \]

\[ \sigma_{\text{max}} = \frac{P}{A} = \frac{3000 \text{lb}}{2 \text{in}^2} = 1500 \text{ psi} \]

\[ \sigma_{\text{max}} \text{, } \text{Tensile} = 7159 + 1500 = 8659 \text{ psi} \]
A 15 inch long aluminum column made by extruding alloy 7075-T6 has the following properties:

a. \( E = 10,000,000 \) psi
b. \( C = 1.2 \)
c. \( \sigma_{yp} = 30,000 \) psi
d. A hollow rectangular cross-section with a wall thickness of 0.030 inches.

1. Calculate the \( P_{cr} \) load associated with a crippling failure of the column.
2. Calculate the \( P_{cr} \) load associated with global buckling of the column.

\[ P_{cr} = \frac{2}{1 - \frac{t}{2t}} \cdot \frac{b_1}{t_1} \cdot F_{cc1} \]

\( b_1 = 2.03 \), \( t_1 = 0.03 \), \( b_1 = 67.6 \), \( F_{cc1} = 25 \) kips

\[ P_{cr} = 2.03 \cdot \frac{0.03}{0.03} \cdot 67.6 \]

\( P_{cr} = 5,517 \) kips

\[ P_{cr} = \frac{2}{1 - \frac{t_2}{2t_2}} \cdot \frac{b_2}{t_2} \cdot F_{cc2} \]

\( b_2 = 1.03 \), \( t_2 = 0.030 \), \( b_2 = 34.3 \), \( F_{cc2} = 40 \) kips

\[ P_{cr} = \frac{2}{1 - \frac{0.030}{2 \cdot 0.030}} \cdot \frac{34.3}{0.030} \cdot 40 \]

\( P_{cr} = 9,918 \) kips

\[ \frac{\text{a)} \text{ Crippling Failure}}{\text{b)} \text{ Global Buckling}} \]

\[ \frac{L}{k} = \sqrt{\frac{2\pi^2 E}{\sigma_{yp}}} = 88.9 \]

\[ T_{min} = \frac{h_2 (2.03)(1.03)^3 - h_2 (2)(1)^3}{(204.45) - (116.67)} = 0.03779 \text{ in}^3 \]

\[ A_{min} = \sqrt{\frac{T_{min}}{A}} = \sqrt{\frac{0.03779}{A}} \]

\[ k_{min} = \frac{0.03779}{1836} = 0.04537 \text{ in} \]

so, \( L/k_{min} = 151.4537 \text{ in} \) = 33.1

and we have a "short column,

use Johnson's formula

\[ \frac{P_{cr}}{A} = a - b \left( \frac{L}{k_{min}} \right)^2 \]

\[ a = \sigma_{yp} = 30,000 \text{ psi}, \quad b = \frac{(\frac{\sigma_{yp}}{2\pi})^2}{CE} \]

\[ b = 1.90 \]

\[ P_{cr} = 30,000 - 1.90 (33.1)^2 = 27918 \]

\[ P_{cr} = 5125 \text{ kips} \]