A steel bar is suspended from the ceiling of a structure. The cross-sectional area of the bar is 5 in². There is a 1000 lb force applied at the bottom end of the bar as shown. Assume that the modulus of elasticity of steel is equal to $30 \times 10^6$ psi, and that it has a unit weight of $490 \frac{lb}{ft^3}$.

Calculate the maximum deflection at B.

First it is necessary to develop an expression that gives the internal force as a function of position $x$ measured from the bottom of the bar.
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\[ W = (x)(5)(.2836) \]  
\[ W = 1.418x \text{ lb} \]  
where \( x \) is in inches

\[ P = 1000 + 1.418x \]  

The total deflection is then given as:

\[ \delta = \int_{0}^{360} \frac{P(x)}{AE} \, dx \]  

\[ \delta = \frac{1}{AE} \int_{0}^{360} (1000 + 1.418x) \, dx \]  

\[ \delta = \frac{1}{AE} \left[ 1000x + \frac{1.418x^2}{2} \right]_{0}^{360} \]
\[ S_{AB} = \frac{1}{AE} \left[ 360000 + 91,886 \right] \]  
\[ S_{AB} = \frac{451,886}{\left(5\right)\left(30 \times 10^6\right)} \]  
\[ S_{AB} = 3.01 \times 10^{-1} \text{ in} \]  

The normal stress at any point \( x \) is given as follows:

\[ \sigma(x) = \frac{1000 + 1.918x}{5 \text{ in}^2} \]  
\[ \sigma(x) = 200 + 283.6x \frac{16}{\text{in}^2} \]  

The maximum stress occurs at point \( A \) where \( x \) will be equal to 360 in.

\[ \sigma_{\text{max}} = 200 + 283.6 \left(360\right) \]  
\[ \sigma_{\text{max}} = 302.1 \frac{16}{\text{in}^2} \]