A horizontal beam ABC is pin-supported at A and carries a load Q at end C as shown. The beam is supported at B by a round steel column with a diameter of 4 in. The modulus of elasticity of the steel is 30×10^6 psi and the yield strength is 40,000 psi. What is the maximum load that may be applied to point C if there is to be a factor of safety 2.0 against failure of the column by yielding or buckling.

First we will determine the maximum allowable compressive load on the column.

Check yielding criteria

\[ A_{\text{column}} = \pi \left( \frac{d}{2} \right)^2 = 12.57 \text{ in}^2 \]
\[ P_{\text{allow}} = \frac{\sqrt{\text{yield}}}{F \cdot L} \]

\[ P_{\text{allow}} = \frac{4,000 \text{ psi}}{2} \]

\[ P_{\text{allow}} = 20,000 \text{ psi} \]

\[ P_{\text{allow}} = (20,000 \text{ psi})(12.57 \text{ in}^2) \]

\[ P_{\text{allow}} = 251,400 \text{ lb} \]

Check Buckling Criteria

\[ I = \frac{\pi}{2} r^4 \]

\[ I = \frac{\pi}{2} (2)^4 \]

\[ I = 12.57 \text{ in}^4 \]

It is just a coincidence that \( I = A \). Usually this will not happen.
\begin{align*}
(11) \quad P_{cr} &= \frac{\pi^2 \cdot E \cdot I}{L^2} \\
(12) \quad P_{cr} &= \frac{\pi^2 (30 \times 10^6 \cdot \frac{ft^2}{in^4}) \cdot 12.57 \cdot in^4}{(84)^2} \\
(13) \quad P_{cr} &= 527,470 \text{ lb} \\
(14) \quad P_{allow} &= \frac{P_{cr}}{F_iS} \\
(15) \quad P_{allow} &= \frac{527,470}{2} \\
(16) \quad P_{allow} &= 263,735 \text{ lb}
\end{align*}

Since 251,400 lb < 263,735 lb then failure by yielding controls.

Hence the maximum allowable compressive load or the column is 251,400 lb.

To determine the maximum allowable load \( Q \) that can be applied to the system it is necessary to examine a F.E.D at A.E.
\[ M_A = 0 \]

\[ + (251,400 \text{ lb})(3 \text{ ft}) - \frac{Q_{\text{Allow}}}{(8 \text{ ft})} = 0 \]

\[ Q_{\text{Allow}} = 94,275 \text{ lb} \]