2) a) We need $T$ and $C_w$ for the I-beam.

\[ T = \frac{Eb^3}{3} \text{ assuming thin plate,} \]

\[ = 2(12) \left( \frac{t_f^3}{3} \right) + (19.4) \left( \frac{t_w^3}{3} \right) \]

\[ = 4.9 \text{ in}^4 \]

\[ C_w = \frac{I_f}{h^2} \]

\[ = \frac{(t_f)(12^3)}{12} \cdot \frac{(21)^2}{2} \]

\[ = \frac{I_f}{h^2} \]

\[ = 25.401 \text{ in}^6 \rightarrow \lambda = \sqrt{\frac{6J}{EC_w}} = 8.4e^{-3} \text{ atm sec} \]

Assume same b.c. as in example in class.

\[ \phi_{xyz} = \frac{T^{1/2}}{2GJ} - \frac{T \sinh \lambda^{1/2}}{2GJ \cos \lambda^{1/2}} \]

\[ = T \left( 8.35e^{-4} - 7.05e^{-4} \right) \]

\[ = T \left( 1.3e^{-4} \right) \text{ rad.} \]

b) $t_f$ affects $T$ and $t_w$ affects $T$ and $C_w$.

We solved iteratively numerically to find

\[ t_f 0.8 \rightarrow 0.9475 \text{ in} \]

\[ t_w 0.5 \rightarrow 1.05 \text{ in} \]

This tells us that, as for bending, the flanges are primary structural elements for torsion.