5.3 Body Torsion: Backbone Structure

(a) strength: $\tau_{allow} = \frac{T}{2At} \rightarrow t = \frac{T}{2A\tau_{allow}} = \frac{6,780,000 Nmm}{2\left(200mm \times 300mm\right)\left(86 N/mm^2\right)} = 0.657mm$

(b) stiffness: $\theta = \frac{Tl}{GJ_{eff}} \rightarrow k = \frac{T}{\theta} = \frac{GJ_{eff}}{l} \xrightarrow{J_{eff} = \frac{4A^2}{\oint \frac{dS}{t}} = \frac{4A^2 t}{S}} k = \frac{T}{\theta} = \frac{G\left(4A^2 t\right)}{lS}$

$$\rightarrow t = \frac{klS}{4A^2 G} = \frac{\left(12,000,000 \frac{Nmm}{\deg} \frac{360\deg}{2\pi rad}\right)\left(2790mm\right)2\left(200mm + 300mm\right)}{4\left(200mm \times 300mm\right)^2 \left(83,000 N/mm^2\right)} = 1.605mm$$

(c) $t_{strength} < t_{stiffness}$

$\rightarrow$ The stiffness requirement is dominant assuming that the walls are stable and do not undergo plate buckling.