4.2 Body Bending: Backbone Structure

(a) strength requirement: $\sigma_{allow} = \dfrac{Mc}{I} = \dfrac{\left(\dfrac{F_{\max} L}{4}\right) c}{I} \rightarrow I_{strength} = \dfrac{LcF_{\max}}{4\sigma_{allow}} = \dfrac{(2790mm)(150mm)(6670N)}{4(175N/mm^2)} = 3.99\times10^6 mm^4$

$I_{strength} = \dfrac{h^2 t(3w+h)}{6} \rightarrow t = \dfrac{6I_{strength}}{h^2(3w+h)} = \dfrac{6(3.99\times10^6 mm^4)}{(300mm)^2(3\times200mm+300mm)} = 0.295mm$

(b) stiffness requirement: $\delta = \dfrac{F_{\max} L^3}{48EI} \rightarrow I_{stiffness} = \dfrac{F_{\max} L^3}{48E\delta} = \dfrac{(6670N)(2790mm)^3}{48(207,000N/mm^2)(1mm)} = 1.46\times10^7 mm^4$

$I_{stiffness} = \dfrac{h^2 t(3w+h)}{6} \rightarrow t = \dfrac{6I_{strength}}{h^2(3w+h)} = \dfrac{6(1.46\times10^7 mm^4)}{(300mm)^2(3\times200mm+300mm)} = 1.08mm$

(f) $I_{strength} = I_{stiffness} \rightarrow \dfrac{LcF_{\max}}{4\sigma_{allow}} = \dfrac{F_{\max} L^3}{48E\delta}$

$\rightarrow L = \sqrt{\dfrac{12E\delta c}{\sigma_{allow}}} = \sqrt{\dfrac{12(207,000N/mm^2)(1mm)(150mm)}{175N/mm^2}} = 1459mm(<2790mm)$

$\rightarrow$ 2-seat car has balanced strength and stiffness requirements.