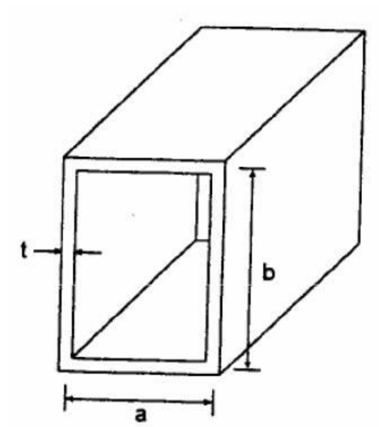
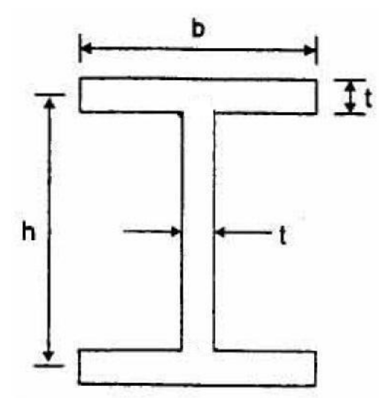
EAS4200C Aerospace Structures Homework #1 (Due: Sep. 4th)



1. The beam of a rectangular thin-walled section (i.e., t is very small) is designed to carry both bending moment M and torque T. If the total wall contour length $L = 2(a+b)$ is fixed, find the optimum b/a ratio to achieve the most efficient section if $M = T$ and $\sigma_{\text{allowable}} = 2\tau_{\text{allowable}}$. Note that for closed thin-walled sections such as the one in the figure, the shear stress due to torsion is $\tau = T/(2abt)$.
Hint: The most efficient section maximizes the section modulus. Write the section modulus as a function of a or b. First assume that bending stress reaches $\sigma_{\text{allowable}}$ and check if shear stress is less than its allowable. If not, assume shear stress reaches $\tau_{\text{allowable}}$ and check if bending stress is less than its allowable.



2. The dimensions of a steel (300M) I-beam are $b = 50\text{mm}$, $t = 5\text{mm}$, and $h = 200\text{mm}$. Assume that t and h are to be fixed for an aluminum (7075-T6) I-beam. Find the width b for the aluminum beam so that its bending stiffness EI is equal to that of the steel beam. Compare the weights-per-unit length of these two beams. Which is more efficient weight-wise? The densities of steel and aluminum are 7.8 and 2.78g/cm^3, respectively.

3. Compare the load-carrying capabilities of two beams having the respective cross-sections shown in the figure. Use bending stiffness as the criterion for comparison. It is given that $a = 4\text{cm}$, $t = 0.2\ \text{cm}$, and the two cross-sections have the same area.