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 \( 2.78 \text{g/cm}^3 \), 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.