*11–60. If the beam is made of material having an allowable tensile and compressive stress of \((\sigma_{\text{allow}}^t) = 125 \text{ MPa}\) and \((\sigma_{\text{allow}}^c) = 150 \text{ MPa}\), respectively, determine the maximum allowable internal moment \(M\) that can be applied to the beam.

**SOLUTION**

**Section Properties:** The neutral axis passes through centroid \(C\) of the cross section as shown in Fig. \(a\). The location of \(C\) is

\[
\bar{y} = \frac{\sum yA}{\sum A} = \frac{0.015(0.03)(0.3) + 0.18(0.3)(0.03)}{0.03(0.3) + 0.3(0.03)} = 0.0975 \text{ m}
\]

Thus, the moment of inertia of the cross section about the neutral axis is

\[
I = \frac{1}{12}(0.3)(0.03^3) + 0.3(0.03)(0.0975 - 0.015)^2 + \frac{1}{12}(0.03)(0.3)^3
+ 0.03(0.3)(0.18 - 0.0975)^2
= 0.1907(10^{-3}) \text{ m}^4
\]

**Allowable Bending Stress:** The maximum compressive and tensile stress occurs at the top and bottom-most fibers of the cross section. For the top-most fiber,

\[
(\sigma_{\text{allow}}^c) = \frac{Mc}{I} = \frac{150(10^6)M(0.33 - 0.0975)}{0.1907(10^{-3})} = 123024.19 \text{ N} \cdot \text{m} = 123 \text{ kN} \cdot \text{m} \text{ (controls)} \quad \text{Ans.}
\]

For the bottom-most fiber,

\[
(\sigma_{\text{allow}}^t) = \frac{My}{I} = \frac{125(10^6)M(0.0975)}{0.1907(10^{-3})} = 244471.15 \text{ N} \cdot \text{m} = 244 \text{ kN} \cdot \text{m}
\]