STRENGTH OF MATERIALS II

Shear and Bending

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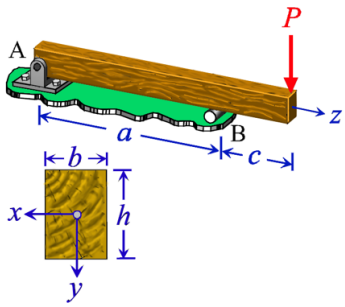
Question : A concentrated load P is applied at the end of the given beam. The width and thickness of the cross-section are $b = 40\,\text{mm}$ and $h = 90\,\text{mm}$, respectively. If the allowable stress is $\sigma_{\text{allow}} = 10\,\text{MPa}$ and the allowable shear stress is $\tau_{\text{allow}} = 1.4\,\text{MPa}$, determine the maximum magnitude of the load P which will not cause the failure of the system. $(a = 2\text{m}, c = 0.4\text{m})$.



Solution:

The maximum shear and bending moment is obtained as,

$$T_{\max} = P \quad ; \quad M_{\max} = \left|-0.4P\right|$$

The moment of area and the moment of inertia is obtained as,

$$\bar{S}_x = \left(-\frac{1}{4}h\right)\left(\frac{1}{2}bh\right) = -40500\ \text{mm}^3$$

$$I_x = \frac{1}{12}bh^3 = 243\times10^4\ \text{mm}^4$$

The maximum stresses compare to the allowable stresses,

$$\sigma_{\max} = \frac{M_{\max}}{I_x}\left(\frac{1}{2}h\right) = \frac{\left|-0.4P\right|}{I_x}\left(\frac{1}{2}h\right) \le \sigma_{\text{allow}} = 10\ \text{MPa}$$

$$\tau_{\max} = -\frac{T_{\max}\,\bar{S}_x}{I_x b} = -\frac{P\,\bar{S}_x}{I_x b} \le \tau_{\text{allow}} = 1.4\ \text{MPa}$$

The allowable load is;

$$P_M \le \frac{10\left(243\times10^4\right)}{(-45)(-0.4)} = 1350\ \text{kN}$$

$$P_T \le \frac{1.4\left(243\times10^4\right)40}{(-40500)} = \boxed{3.36\ \text{kN}}$$