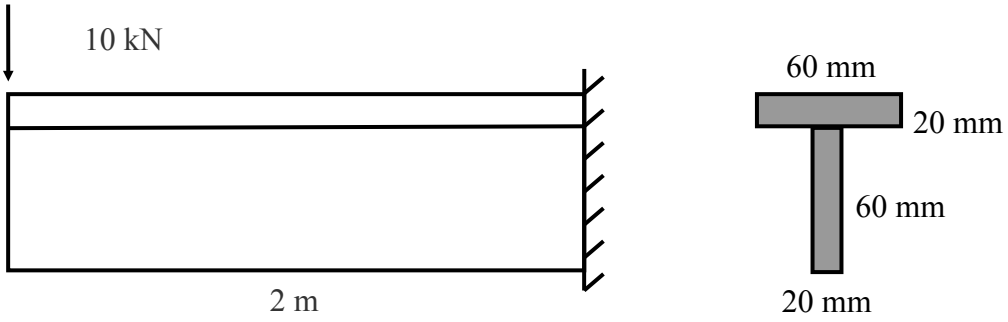
TOPIC
Strength of Materials – Section VIII – Question 5

QUESTION
A cantilever beam is loaded with a force of 10 KN and has a cross-section as shown. The maximum tensile stress in MPa in the beam most nearly is



(A) 4.16
(B) 441
(C) 588
(D) 735

HINT
The second moment of area of the cross section is $1.36 \times 10^{-6} m^4$
The top of the beam is in tension.
The centroid is 50 mm up from the bottom of the cross section
The maximum moment is 20 KN–m.

SOLUTION
Noting that y is measured from the bottom, the y-centroid location of the cross-section is

$$\begin{aligned}\overline{y} &= \frac{\sum A_i y_i}{\sum A_i} \\ &= \frac{(60)(20)(70)+(20)(60)(30)}{(60)(20)+(20)(60)} \\ &= 50\text{mm}\end{aligned}$$

The second moment of area is found by using the parallel-axis theorem

$$\begin{aligned}I &= \sum \left(\overline{I_i} + A_i y_i^{*2}\right) \\ &= \left(\frac{1}{12}(60)(20)^3 + (60)(20)(20)^2\right) + \left(\frac{1}{12}(20)(60)^3 + (20)(60)(20)^2\right) \\ &= 1360000\text{mm}^4 \\ &= 1.36 \times 10^{-6} m^4\end{aligned}$$

The bending moment at any location is given by

$$M(x) = -Px$$

and hence the maximum bending moment is at $x=L$

$$M_{max}$$
$$= -(10 \times 10^3)(2)$$
$$= -20000\text{Nm}$$

The maximum tensile stress would be at the top of the cross-section and is given by

$$\sigma = -\frac{My}{I}$$
$$= -\frac{-20000 \times (30 \times 10^{-3})}{1.36 \times 10^{-6}}$$
$$= 441.17 \times 10^6\text{Pa}$$
$$\approx 441\text{ MPa}$$

ANSWER

(B)

CONTRIBUTOR

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