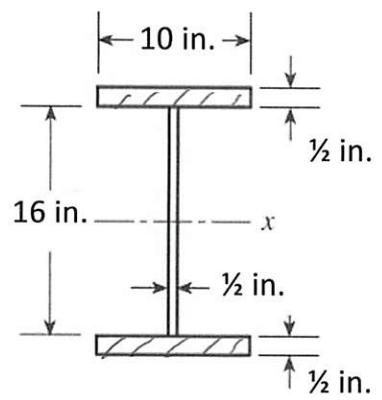


Classroom Problem 5.2-1: For the built-up shape below, determine: (a) the elastic section modulus **S**, and the yield moment **M_y**, and (b) the plastic section modulus **Z** and the plastic moment **M_p**. Bending is about the **x**-axis, and the steel is **A572 Grade 50** with **F_y = 50 ksi**; **F_u = 65 ksi**.



* SYMMETRIC SECTION

$$S = \frac{I}{c} \quad I = \bar{I}_x + Ad^2$$

TOP FLANGE

$$\bar{I}_x = \frac{bh^3}{12} = \frac{(10\text{ in})(\frac{1}{2}\text{ in})^3}{12} = 0.1042\text{ in}^4$$

$$A = bh = 10\text{ in}(\frac{1}{2}\text{ in}) = 5\text{ in}^2$$

$$d = \frac{16\text{ in}}{2} + (\frac{1}{2}\text{ in})\frac{1}{2} = 8.25\text{ in}$$

BOTTOM FLANGE \Rightarrow SAME AS TOP FLANGE

WEB

$$\bar{I}_x = \frac{bh^3}{12} = \frac{(\frac{1}{2}\text{ in})(16\text{ in})^3}{12} = 170.667\text{ in}^4$$

$$A = bh = (\frac{1}{2}\text{ in})(16\text{ in}) = 8\text{ in}^2$$

$$d = 0$$

CR PROBLEM 5.2-1

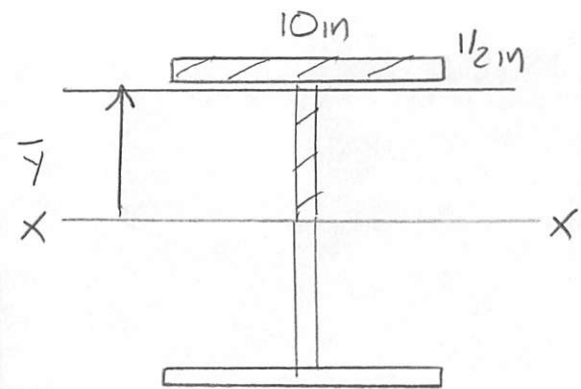
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	$\bar{I}_x (\text{in}^4)$	$A (\text{in}^2)$	$d (\text{in})$	$\bar{I}_x + Ad^2 (\text{in}^4)$
FLANGE - TOP	0.1042	5	8.25	340.417
FLANGE - BOTTOM	0.1042	5	8.25	340.417
WEB	170.667	8	0	170.667
		<u>18 in²</u>		<u>$I_x = 851.50 \text{ in}^4$</u>

$$S = \frac{I_x}{c} = \frac{851.50 \text{ in}^4}{16 \text{ in}/2 + 1/2 \text{ in}} = \underline{100.176 \text{ in}^3}$$

$$M_y = F_y S = 50 \text{ ksi} (100.176 \text{ in}^3) = 5,008.82 \text{ k}\cdot\text{in} = \underline{\underline{417.4 \text{ k}\cdot\text{ft}}}$$

SYMMETRIC SECTION - DIVIDE INTO EQUAL AREA \Rightarrow PNA



FLANGE $A = 10\text{ in} \left(\frac{1}{2}\text{ in}\right) = 5\text{ in}^2$

$$y = 8\text{ in} + \frac{1}{2} \left(\frac{1}{2}\text{ in}\right) = 8.25\text{ in}$$

WEB $A = 8\text{ in} \left(\frac{1}{2}\text{ in}\right) = 4\text{ in}^2$

$$y = \frac{1}{2} (8\text{ in}) = 4\text{ in}$$

$$\bar{y} = \frac{\sum A y}{\sum A} = \frac{(5\text{ in}^2) 8.25\text{ in} + 4\text{ in}^2 (4\text{ in})}{5\text{ in}^2 + 4\text{ in}^2} = \underline{6.361\text{ in}}$$

$$Z = \frac{A}{z} a = \left(\frac{18\text{ in}^2}{z}\right) z (6.361\text{ in}) = \underline{114.50\text{ in}^3}$$

$$M_p = F_y Z = 50\text{ ksi} (114.5\text{ in}^3) = 5,725\text{ k}\cdot\text{in} = \underline{\underline{477,08\text{ kft}}}$$