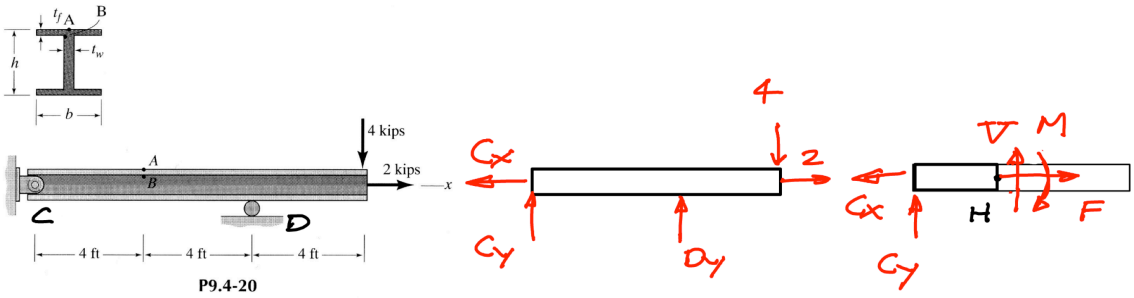
Example 16.5

An I-beam with a cross-section shown is subjected to axial and transverse loads at its right end. Determine the principal stresses in the beam at B. Use: $h = 12\ in$ and $t_f = t_w = 1\ in$.



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Using FBD of entire beam:

$\sum F_x = -C_x + 2 = 0 \Rightarrow C_x = 2\ kips$

$\sum M_C = D_y(8) - (4)(12) = 0 \Rightarrow D_y = 6\ kips$

$\sum F_y = C_y + D_y - 4 = 0 \Rightarrow C_y = -2\ kips$

Using FBD of cut section:

$\sum M_H = -C_y(4) - M = 0 \Rightarrow M = 8\ kip\cdot ft = 96\ kip\cdot in$

$\sum F_y = C_y + V = 0 \Rightarrow V = 2\ kips$

$\sum F_x = -C_x + F = 0 \Rightarrow F = 2\ kips$

Stresses at cut

At point B ($y = \frac{h}{2} - t_f$)

$$\sigma = \sigma_1 + \sigma_2\Big|_y = \frac{F}{A} + \frac{My}{I}$$

$$\tau = \frac{V A^* \bar{y}^*}{I t}$$

w/ I = 2nd area moment of cross-section

A = area of cross-section

$A^* = b t_f$

$\bar{y}^* = \frac{h}{2} + \frac{t_f}{2}$ & $t = t_w$