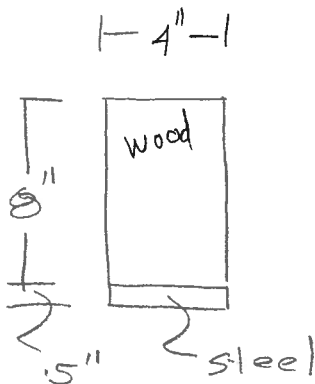


The composite beam shown is subject to a positive moment of 20,000 in-lb. Determine the maximum bending stress in the wood and the steel.



$$E_{\text{wood}} = 2 \times 10^6 \text{ psi}$$

$$E_{\text{st}} = 30 \times 10^6 \text{ psi}$$

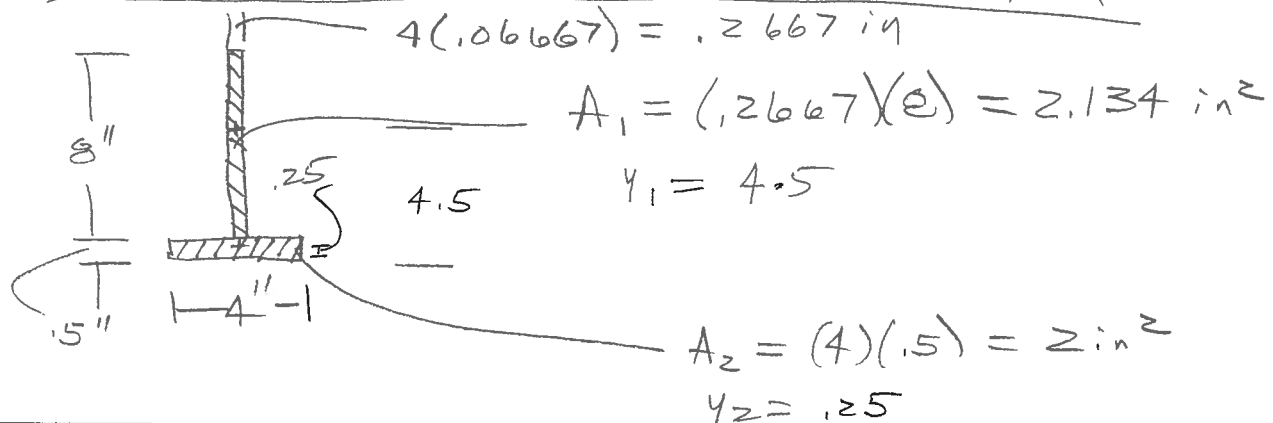
Select steel for the base material

$$(1) \quad n = \frac{E_{\text{wood}}}{E_{\text{st}}}$$

$$(2) \quad n = \frac{2 \times 10^6}{30 \times 10^6}$$

$$(3) \quad n = .06667$$

Construct modified cross-section

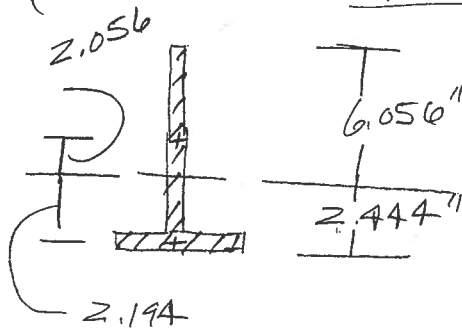


Locate centroid of modified cross-section

$$(4) \quad \bar{y} = \frac{\sum A_i y_i}{\sum A_i}$$

$$(5) \quad \bar{y} = \frac{(2.134)(4.5) + (2)(.25)}{2.134 + 2}$$

$$(6) \quad \bar{y} = 2.444 \text{ in}$$



$$(7) \quad I = \frac{1}{12} (.2667)(8)^3 + (.2667)(8)(2.056)^2 + \frac{1}{12} (4)(.5)^3 + (4)(.5)(2.194)^2$$

$$(8) \quad I = 11.379 + 9.019 + .042 + 9.627$$

$$(9) \quad \underline{I = 30.07 \text{ in}^4}$$

The maximum flexural stress in the wood occurs at the top of the beam and is compressive. The value of y is 6.056.

$$(10) \quad \sigma_{wood} = - \frac{n M y}{I}$$

$$(11) \quad \sigma_{wood} = - \frac{(1.06667)(20,000 \text{ in-lb})(6.056 \text{ in})}{30.07 \text{ in}^4}$$

$$(12) \quad \sigma_{wood} = - 268.5 \text{ psi}$$

The maximum stress in the steel is at the bottom of the beam and is tension. The value of y is -2.444 in.

$$(13) \quad \sigma_{stl} = - \frac{M y}{I}$$

$$(14) \quad \sigma_{stl} = - \frac{(20,000 \text{ in-lb})(-2.444 \text{ in.})}{30.07 \text{ in}^4}$$

$$(15) \quad \sigma_{stl} = 1,625.5 \text{ psi}$$

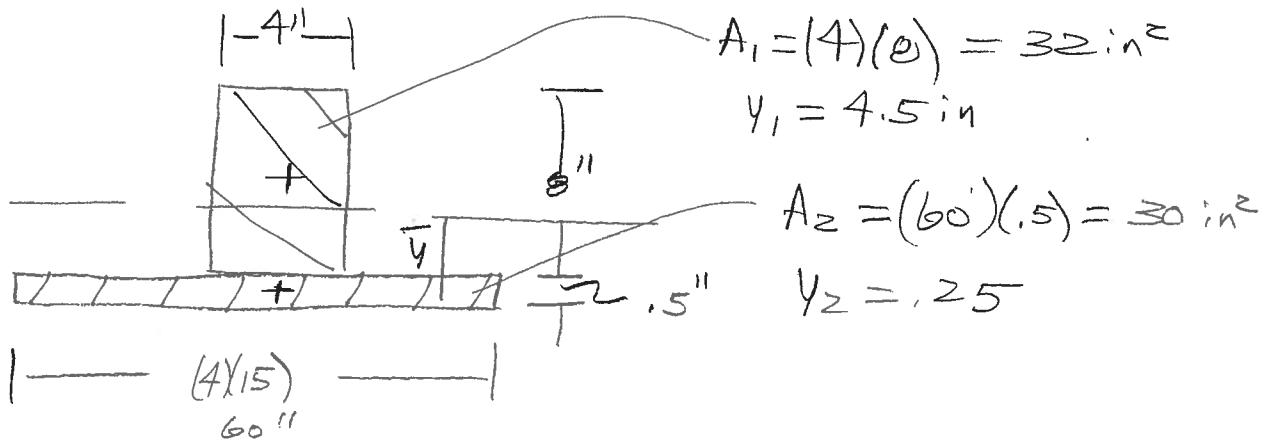
Next we will select wood for the base material.

$$(16) \quad n = \frac{E_{stl}}{E_{wood}}$$

$$(17) \quad n = \frac{30 \times 10^6 \text{ psi}}{2 \times 10^6 \text{ psi}}$$

$$(18) \quad n = 15$$

Construct the modified cross-section



Locate the centroid of the modified cross-section.

$$(1) \quad \bar{y} = \frac{\sum A_i y_i}{\sum A_i}$$

$$(2c) \quad \bar{y} = \frac{(32)(4.5) + (30)(.25)}{32 + 30}$$

$$(2i) \quad \bar{y} = 2.444 \text{ in}$$

$$(2) \quad I = \frac{1}{12} (4)(8)^3 + (4)(8)(4.5 - 2.444)^2 + \frac{1}{12} (60)(1.5)^3 + (60)(1.5)(.25 - 2.444)^2$$

$$(3) \quad I = 170.7 + 135.3 + .625 + 144.4$$

$$(4) \quad \underline{I = 451 \text{ in}^4}$$

The maximum flexural stress in the wood is at the top of the wood where $y = 8.5 - 2.444 = 6.056$ in.

$$(25) \quad \sigma_{\text{wood}} = - \frac{M y}{I}$$

$$(26) \quad \sigma_{\text{wood}} = - \frac{(20000 \text{ in-lb})(6.056 \text{ in})}{451 \text{ in}^4}$$

$$(27) \quad \sigma_{\text{wood}} = -268.6 \text{ psi} \quad (\text{Compression})$$

The maximum flexural stress in the steel occurs at the bottom of the steel where $y = -2.444$ in.

$$(28) \quad \sigma_{\text{stl}} = - \frac{n M y}{I}$$

$$(29) \quad \sigma_{\text{stl}} = - \frac{15 (20000 \text{ in-lb})(-2.444)}{451 \text{ in}^4}$$

$$(30) \quad \sigma_{\text{stl}} = 1625.7 \text{ psi} \quad \text{Tension}$$

