

PROBLEM 5.7-7 A hollow wood beam with plywood webs has the cross-sectional dimensions shown. The plywood is attached to the flang by means of small nails having an allowable load in shear of 30 lb. Find the maximum allowable spacing s of the nails at cross sections where the shear force V is equal to (a) 200 lb and (b) 300 lb.

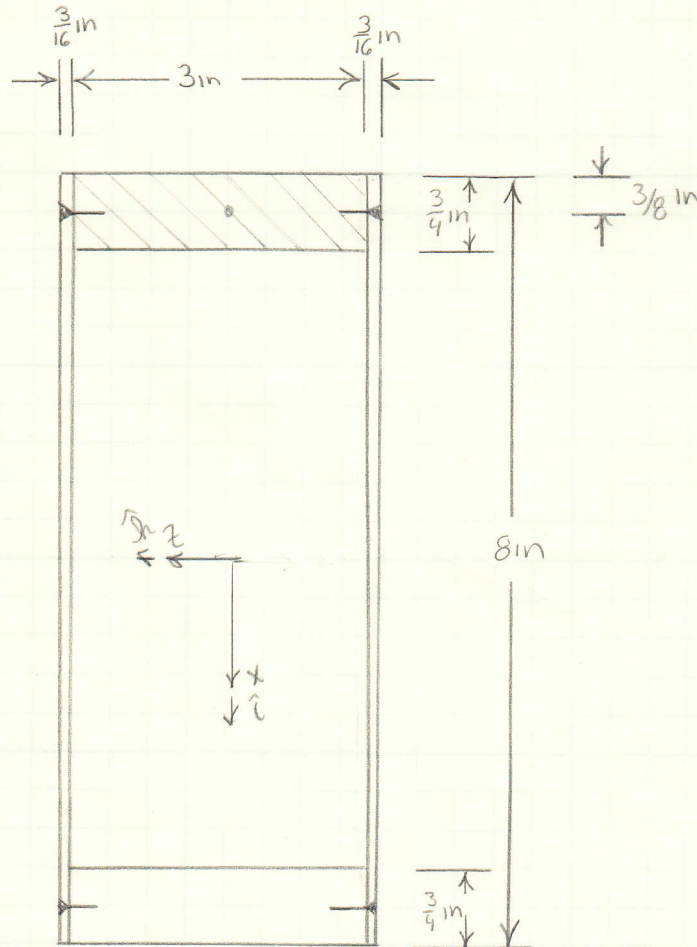
GIVEN:

- 1) CONSTRAINT
 - hollow plywood beam shown
 - small nails with allowable shear load of 30 lb
- 2) Assumptions
 - linear elastic material
 - small deflections

FIND:

- 1) maximum allowable spacing when the shear force is 200 lb
- 2) maximum allowable spacing when the shear force is 300 lb

DIAGRAM:



Mechanics:

The solution of this problem requires the calculation of the shear flow in the shaded section of the box beam

$$q = \frac{VQ}{I} \quad (1)$$

We start by calculating the moment of inertia of the cross-section about the section's centroidal axis.

$$\begin{aligned} I &= 2 \cdot \frac{1}{12} \left(\frac{3}{16} \text{ in} \right) (8 \text{ in})^3 \\ &\quad + 2 \cdot \left[\frac{1}{12} (3 \text{ in}) \left(\frac{3}{4} \text{ in} \right)^3 + (3 \text{ in}) \left(\frac{3}{4} \text{ in} \right) \left(4 \text{ in} - \frac{3}{8} \text{ in} \right)^2 \right] \\ &= \underline{75.34 \text{ in}^4} \quad (2) \end{aligned}$$

Q for the shaded section is given by

$$Q = \bar{X} A = (4 \text{ in} - \frac{3}{8} \text{ in}) \cdot (3 \text{ in}) \left(\frac{3}{4} \text{ in} \right) = \underline{8.156 \text{ in}^3} \quad (3)$$

Now from 1 the shear flow for the two cases under consideration

$$q(2000 \text{ lb}) = \frac{2000 \text{ lb} \cdot 8.156 \text{ in}^3}{75.34 \text{ in}^4} = 21.65 \frac{\text{lb}}{\text{in}}$$

$$q(3000 \text{ lb}) = \frac{3000 \text{ lb} \cdot 8.156 \text{ in}^3}{75.34 \text{ in}^4} = 32.48 \frac{\text{lb}}{\text{in}}$$

Knowing that $\frac{2 \cdot F_{\text{all}}}{s} = q$; therefore $s = \frac{2 \cdot F_{\text{all}}}{q}$

$$s(2000 \text{ lb}) = \boxed{2.77 \text{ in}}$$

$$s(3000 \text{ lb}) = \boxed{1.85 \text{ in}}$$

SUMMARY:

The key to solving spacing problems is picking the right section. The section picked in this example had two nails in it; therefore 2 times the allowable load was required to be used.