PROBLEM 5.7-7 | A hollow wood beam with plywood webs has the cross-sectional dimensions shown. The plywood is attached to the flange 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.
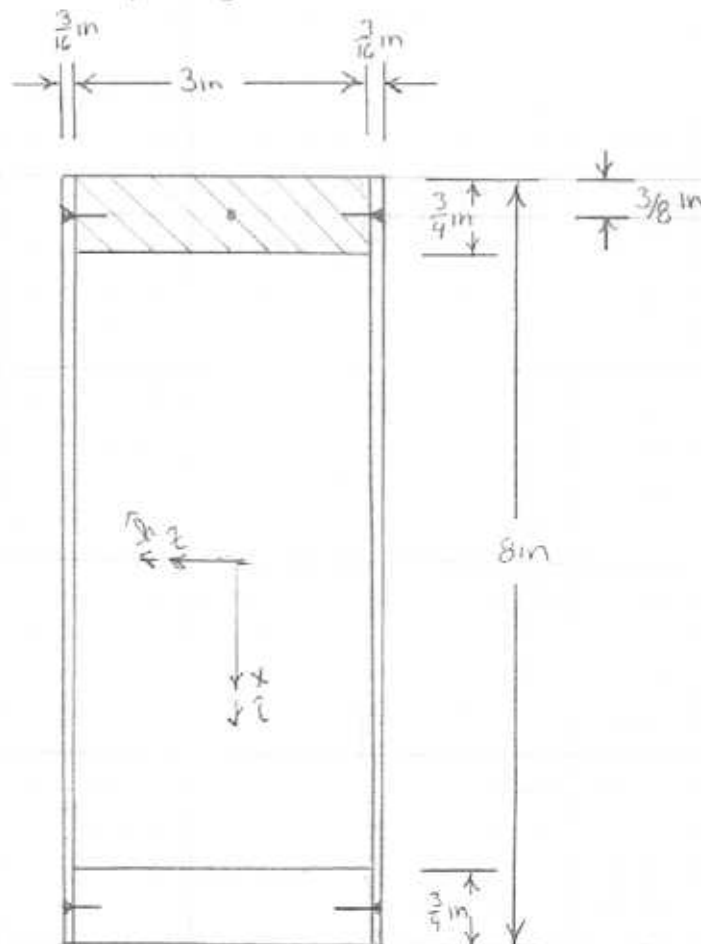
GIVEN:

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:

ESC030: Mechanics of Deformable Solids
Assignment #6

Mechanics:

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

$$q = \frac{VQ}{I} \qquad \text{①}$$

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

$$I = 2 \cdot \frac{1}{12} \left(\frac{3}{16} in\right)(8 in)^3$$

$$+ 2 \cdot \left[\frac{1}{12}(3 in)\left(\frac{3}{4} in\right)^3 + (3 in)\left(\frac{3}{4} in\right)\left(4 in - \frac{3}{8} in\right)^2 \right]$$

$$= \underline{75.34 in^4} \qquad \text{②}$$

Q for the shaded section is given by

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

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

$$q(200 lb) = \frac{200 lb \cdot 8.156 in^3}{75.34 in^4} = 21.65 \frac{lb}{in}$$

$$q(300 lb) = \frac{300 lb \cdot 8.156 in^3}{75.34 in^4} = 32.48 \frac{lb}{in}$$

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

$$s(200 lb) = \boxed{2.77 in}$$

$$s(300 lb) = \boxed{1.85 in}$$

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.