Ch 5  Shear Stresses in Beams

Review

Example 5-16 pp 357 (modified)

Given: Section shown carrying $V = 10.5\, kN$
- Nail spacing = 0.100 m
- Find: Shear force in each nail

Solution: Assume glued

$T_{\text{glue}} = \frac{VQ}{Ib}$

$F_{\text{nail}} = T_{\text{glue}} \cdot \text{Ague/nail}$
T_{\text{glue}} = \frac{V_0}{b}

\{ \begin{array}{l}
Q = \bar{A} \ast \\
b = 2(0.04m)
\end{array} \}

I = \text{moment for the section about G (found by symmetry)}

\begin{align*}
I &= 2 \left[ \frac{1}{12} (0.015m) (0.280m)^3 \right]_{\text{WEBS}} \\
&+ 2 \left[ \frac{1}{12} (0.180m) (0.040m)^3 + (0.120m)^2 (0.040m)(0.180m) \right]_{\text{fl}} \\
I &= \frac{0.000209}{m^4}
\end{align*}

Q = (0.120m)(0.040m)(0.180m) = 0.000864 m^3

T_{\text{glue}} = \frac{(10.5kN)(0.000864m^3)}{(0.000209m^4)(0.080m)} = 540 \text{ kPa}

k-d = 0.100m

A_{\text{fl}} = (0.040m)(0.100m) = 0.004 \text{ m}^2

F_{\text{final}} = T_{\text{glue}} \frac{A_{\text{fl}}}{A_{\text{fl}}} = (504 \text{ kPa})(0.004 \text{ m}^2)

F_{\text{final}} = 2.16 \text{ kN}
What if we want to find nail spacing such that $F_{\text{nail}} \leq 800 \text{N}$ (allow force/nail)?

\[
\frac{d}{0.040 \text{m}} \quad \Rightarrow \quad F_{\text{nail}} \leq 800 \text{N}
\]

\[
F_{\text{nail}} = F_{\text{allow}} = 800 \text{N}
\]

\[
\frac{F_{\text{nail}}}{F_{\text{allow}}} = \frac{A_{\text{nail}}}{A_{\text{glue}}}
\]

\[
A_{\text{nail}} = \frac{F_{\text{nail}}A_{\text{glue}}}{F_{\text{allow}}}
\]

\[
d = \frac{F_{\text{nail}}}{\text{tg}_{\text{glue}} (0.040 \text{m})}
\]

\[
= \frac{800 \text{N}}{\frac{540,000 \text{N}}{\text{m}^2} (0.040 \text{m})}
\]

\[
d = 0.037 \text{ m}
\]
Example:

Calc of I: Find I for W12x87 with two channels C15x50 secured to top & bottom flanges.

1. Find centroid G (by symmetry)

2. Find I

\[ I = \left[ 746 \text{in}^4 + 0^2 A_{WF} \right]_{WF} \]

\[ + 2 \left[ 11.0 \text{in}^4 + (6.183 \text{in})^2 (14.7 \text{in}^2) \right] \]

Find Q for rivets

\[ A^t = A_{channel} = 14.7 \text{in}^2 \]

\[ \bar{y} = 6.183 \text{in} \]

\[ Q = (6.183 \text{in}) (14.7 \text{in}^2) = m^3 \]

\[ T_{Shear} = \frac{VQ}{Ib} \]

\[ b = 12.125 \text{in} \] (flange width)
**Top View**

\[ A_{glue/rivet} = (d) \left( \frac{12.125m}{2} \right) \]

\[ F_{net} = T_{glue} - A_{glue/rivet} \]

Stress concentrations in bending – see text.

**Composite Beams**

\[ \sigma = E \varepsilon \]

\[ \varepsilon = \frac{\sigma}{E} \]

Strains (Plane sections remain plain)