Example Problem - Combined Direct Stresses

Given: Joint shown below w 20k load applied to 1/2" thick plate and 10k load applied to the two 1/4" thick plates

Find: All direct stresses (shear, bearing, normal)

Solution:

a) Normal Stress in 1/4" Plates

\[ \tau = \frac{P}{A} = \frac{10k}{(0.25 \text{in})(4\text{in})} \]

\[ \tau = 10 \text{kpsi} \] (Normal stress 1/4" plate)

b) Normal Stress in 1/2" Plate

\[ \tau = \frac{P}{A} = \frac{20k}{(0.5\text{in})(4\text{in})} \]

\[ \tau = 10 \text{kpsi} \] (Normal stress 1/2" plate)

c) Shear Stress in Rivets

\[ \tau = \frac{P}{A_s} = \frac{20k}{6 \text{ (2in)} \times (0.375\text{in})^2} \]

6 Rivets Double Shear Area per Rivet

\[ \tau = 15\text{kpsi} \] (Shear stress in Rivets)
d) Tensile failure through plate \( \Rightarrow \) Calc normal stress

i) \( \frac{1}{4}'' \) plate:

\[
\sigma = \frac{P}{A_t}
\]

Where:
- \( P \) is the load applied
- \( A_t \) is the total area

\[
\sigma = \frac{10k}{[4in - 3(1.375in + .0625in)]/25in}
\]

\( \sigma = 14.9\text{ksi} \) (normal stress through hole section)

(ii) \( \frac{1}{2}'' \) plate:

\[
\sigma = \frac{P}{A_t} = \frac{20k}{[4in - 3(1.375in + .0625in)]/25in}
\]

\( \sigma = 14.9\text{ksi} \) (normal stress through hole section)
e) End Tear out of Plates: (shear stress)

\[ \tau = \frac{F}{A_g} = \frac{10k}{3(2.25\text{ in})(1.5\text{ in} + 1\text{ in})} \]

\[ \tau = 5.33\text{ psi} \quad \text{(shear stress tear out)} \]

f) Bearing stress between plate and rivet:

\[ \tau_b = \frac{P}{A_b} \quad \text{where} \quad A_b = N \cdot d \cdot t \]

\[ \tau_b = \frac{20k}{6(3.75\text{ in})(.5\text{ in})} \]

\[ \tau_b = 17.8\text{ ksi} \quad \text{(bearing stress)} \]

Note: Bearing stress developed between rivets and \( \frac{1}{4} \)" plate will be same (17.8 ksi), why?

At this point all direct stresses have been calculated.