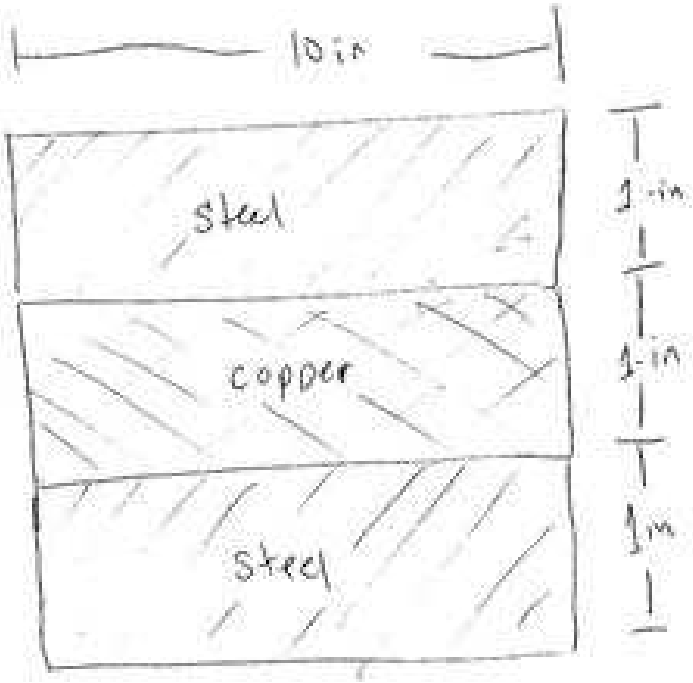
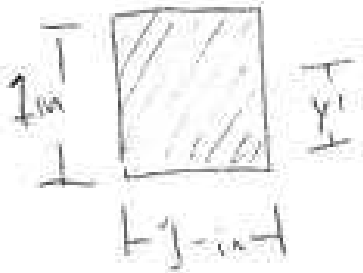
Eq 2 AL Bracket (Plates)

Drawing



X-Sect



Moment of Inertia

$$I_x = \frac{bh^3}{12}$$

$$= \frac{1}{12} \text{ in}^4$$

$y' = 0.5$ in

$A' = 1 \text{ in}^2$

Thermal expansion

$$\Delta L = L_0 \alpha (t_1 - t_0)$$

Engineering strain

$$\varepsilon = \frac{\Delta L}{L_0}$$

$$\varepsilon = \frac{\Delta L}{L_0} = \alpha (t_1 - t_0)$$

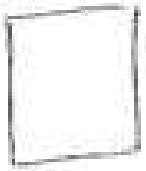
$$\sigma = E \varepsilon$$

$$\sigma = E \alpha (t_1 - t_0)$$

$$\sigma = \frac{P}{A}$$

$$\frac{P}{A} = E \alpha (t_1 - t_0)$$

$$P = A E \alpha (t_1 - t_0)$$

A = 

$A = 1 in^2$

Steel: $E = 30e6$ psi

$\nu = 0.3$

$\alpha = 70e-7$ in/in·F

$$P = (1 in^2)\left(30E6 \frac{lb}{in^2}\right)(70E-7 \, in/in \cdot F)(100°F)$$

$P = 21{,}000$ lbf

Copper:

$E = 16e6 \ lb/in^2$

$\nu = 0.3$

$\alpha = 92 E-7 \ in/in \cdot °F$

$P = (1 in^2)(16 E6 \ lb/in^2)(92 E-7 \ in/in°F)(100°F)$

$P = 14,720 \ lb-f$

Steel:

$\Delta L = (10 in)(70 E-7 \ in/in-°F)(100°F)$

$= 0.007 \ in$

Copper:

$\Delta L = (10 in)(92 E-7 \ in/in-°F)(100°F)$

$= 0.0092 \ in$

Shear modulus

$G = \frac{E}{2(1+\nu)}$

Steel: $G = \frac{30 E6}{2(1+0.3)} = 11,538,461 \ lb/in^2$

Copper: $G = \frac{16 E6}{2(1+0.3)} = 6,153,846 \ lb/in^2$

$$\varepsilon_y = \varepsilon_x = \frac{P}{AE}$$

σ : Steel = $\frac{21{,}000\ lb}{1\ in^2}$ = 21,000 psi

$$\varepsilon_y = \varepsilon_x = \frac{21{,}000\ psi}{30\ e6\ psi} = 7E\text{-}04$$

Copper :

ΔL = 0.0092 in

ε = 0.0092

ε_y : ε_{tot} = $\varepsilon_{steel} + \varepsilon_{copper}$ = 0.0162

ε_x = 0.007 & 0.0092

$$\tau_{xy} = \frac{(21{,}000\ psi)\cdot(1\ in^2)\cdot(0.5\ in)}{\left(\frac{1}{12}\ in^4\right)(1)}$$

τ_{xy} = 126,000 psi

$\gamma_{xy} = \tau_{xy}/G$ = 126,000 / 11,538,461 = 0.01092

$$\begin{Bmatrix}\sigma_x\\ \sigma_y\\ \tau_{xy}\end{Bmatrix} = \frac{E}{1-\nu^2}\begin{bmatrix}1 & \nu & 0\\ \nu & 1 & 0\\ 0 & 0 & \frac{1-\nu}{2}\end{bmatrix}\begin{Bmatrix}\varepsilon_x\\ \varepsilon_y\\ \gamma_{xy}\end{Bmatrix}$$

$$\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} = \frac{E}{1-\nu^2} \begin{bmatrix} 1 & \nu & 0 \\ \nu & 1 & 0 \\ 0 & 0 & \frac{1-\nu}{2} \end{bmatrix} \begin{Bmatrix} \varepsilon_x \\ \varepsilon_y \\ \gamma_{xy} \end{Bmatrix} \begin{matrix} = 0.007 \\ = 0.0092 \\ = 0.01092 \end{matrix}$$

Steel:

$$\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} = \frac{30 \text{ Edd}}{1-(0.3)^2} \begin{bmatrix} 1 & 0.3 & 0 \\ 0.3 & 1 & 0 \\ 0 & 0 & \frac{1-0.3}{2} \end{bmatrix} \begin{Bmatrix} 0.007 \\ 0.0092 \\ 0.01092 \end{Bmatrix}$$

$$= \frac{30 \text{ Edd}}{1-(0.3)^2} \begin{Bmatrix} 0.004659 \\ 0.007002 \\ 0.0312 \end{Bmatrix}$$

$\sigma_x = 153,593$ psi

$\sigma_y = 257,208$ psi

$\tau_{xy} = 1028,571$ psi