Strut Calculation

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Material 6060-T5 Extrusions

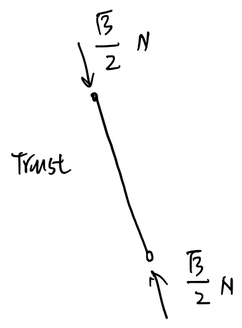
$\sigma_y = 120\,mpa$ $\sigma_u = 160\,mpa$ $E = 69.5\,Gpa$

Axial stress $(\frac{F}{A})^* k$ k is concentration factor
pin loaded hole

$\frac{d}{b} = \frac{6}{20} = 0.3 \rightarrow k = 3.6$

$\sigma_{nom} = \frac{P}{A} = \frac{P}{(b-d)h}$

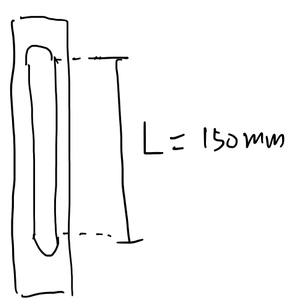
Force on Tie from Torque: 1 N
Force on Strut: $\frac{F_3}{2}$ N



Failure consideration:

① buckling

assumption:



Slenderness ratio $= \frac{Le}{\rho}$ Radius of Gyration $= \rho = \sqrt{\frac{I}{A}}$

Second moment of area $I = \frac{bd^3}{12}\,m^4 = 0.02 \cdot \frac{0.002^3}{12}\,m^4 = 1.33 \times 10^{-11}$

$A = bd = 4 \times 10^{-5}\,m^2$

$\rho = \sqrt{\frac{1.33}{4}\frac{10^{-11}}{10^{-5}}} = 0.5766 \times 10^{-3}$

$\frac{Le}{\rho} = \frac{0.15}{0.5766 \times 10^{-3}} = 260.$

This ratio needs to be compared to the material properties ratio

$\sqrt{\frac{2\pi^2 E}{S_y}} = \sqrt{2\pi^2\, 69.5 \times 10^9 / 120.10^6} = 106.92$

estimates show a slenderness ratio above the material properties ratio.

Euler's buckling will be used

$P_{cr} = A\pi^2 E \rho^2 / Le^2$

$= 4066.48N$

$\frac{F_3}{2} Tie = P_{cr}$

$Tie = \frac{P_{cr}}{F_3} \cdot 2$

These correspond to an input force at the tie of $\frac{2}{F_3} P_{cr}$

So critical input forces, consider there are 2 plane, are.

938.2N

$I = \frac{db^3}{12} = 0.002 \cdot \frac{0.12^3}{12} = 1.33 \times 10^{-7}$

$A = bd = 4 \times 10^{-5}$

$\rho = \sqrt{\frac{1.33 \times 10^{-7}}{4 \times 10^{-5}}} = 0.576 \times 10^{-1}$

$\frac{Le}{\rho} = 2.60$

$\sqrt{\frac{2\pi^2 E}{S_y}} = 106.92$

$P_{cr} = \left[S_y - \frac{S_y^2}{4\pi^2 E}\left(\frac{Le}{\rho}\right)^2\right] A$

$= \left[120 \times 10^6 - 35478\right] 4 \times 10^{-5}$

$= 4798.58\,N$

② axial compression

$S_y = K \cdot \frac{F}{A}$ $K = 3.6$

At two end around pin: $F = \frac{S_y \cdot A}{K} = \frac{120\,mpa \cdot 122\,mm^2}{3.6} = 4066.66N$

At middle no k, but smaller A,

$F = S_y \cdot A = 120\,Mpa \cdot 80mm^2 = 9600\,N$

far more larger than buckling. hence axial compression are not likely to cause failure.