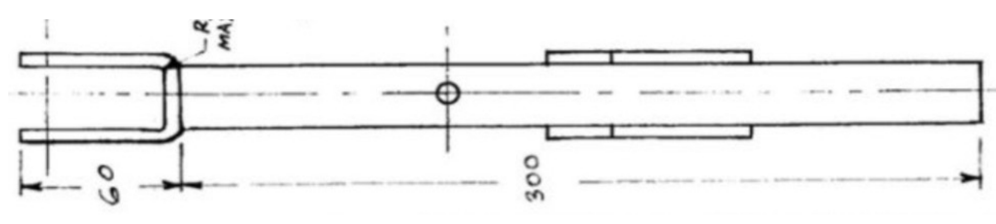
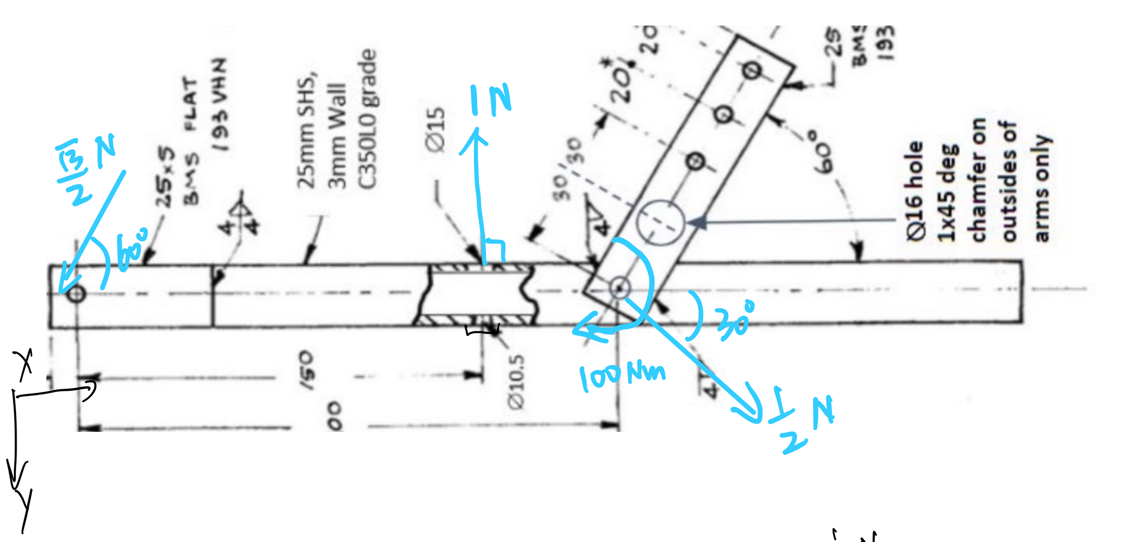
Base calculation

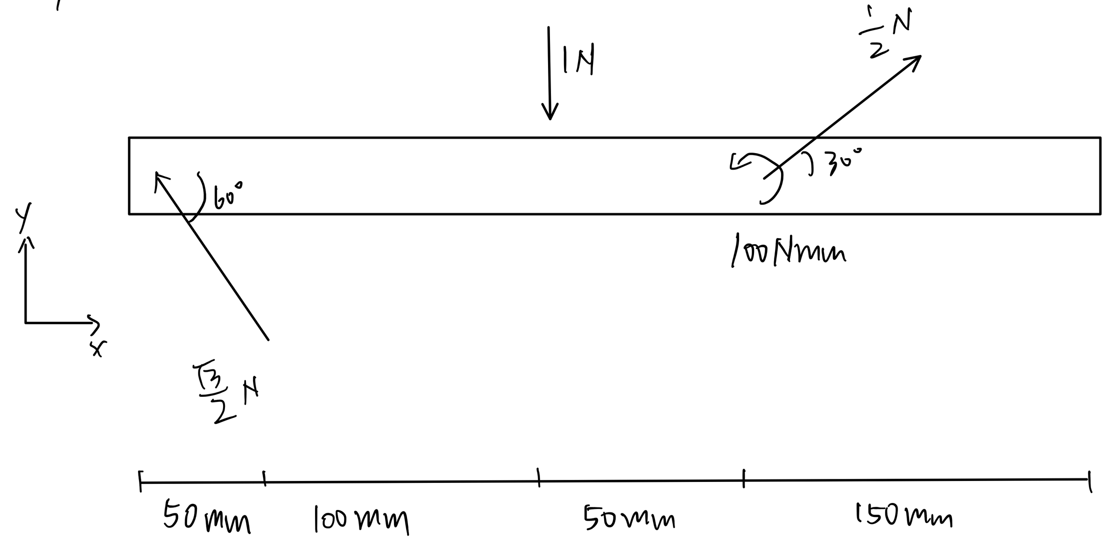
2020年9月28日 星期一 23:52

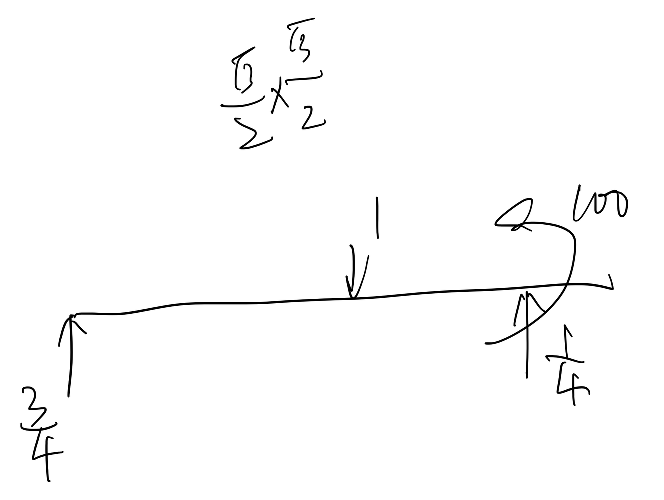
Assume Force on Tie is 1 N



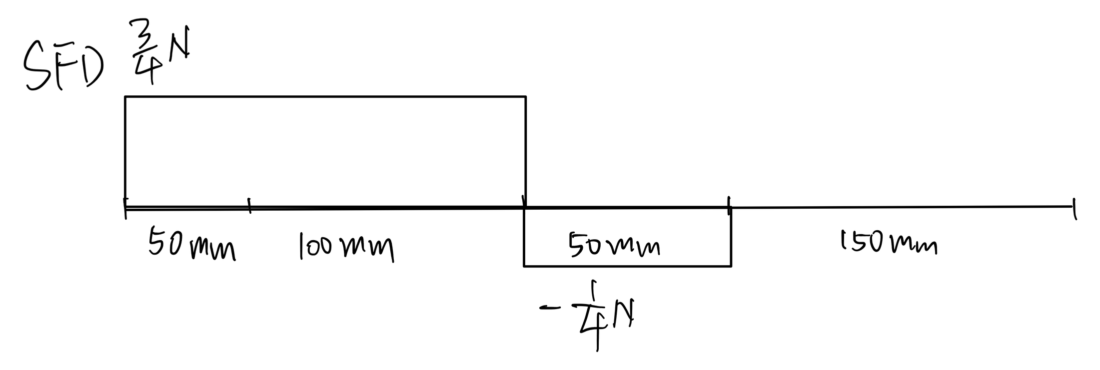


$\sin 60° = \frac{\sqrt{3}}{2}$
$\sin 30° = 0.5$
$\cos 30° = \frac{\sqrt{3}}{2}$
$\cos 60° = 0.5$



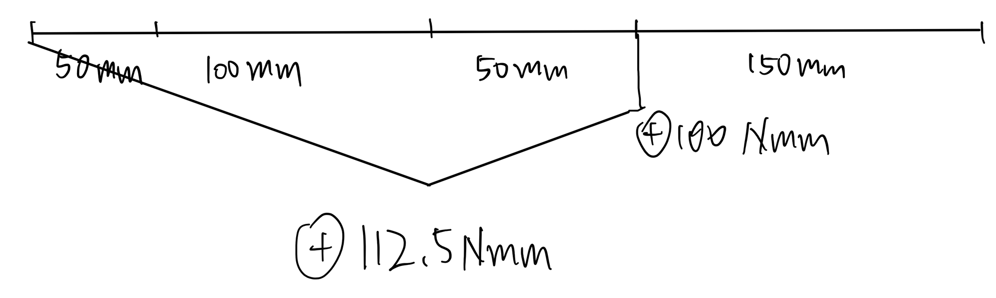


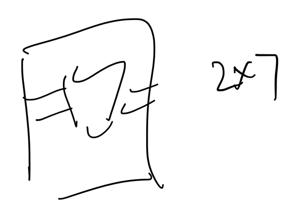
SFD



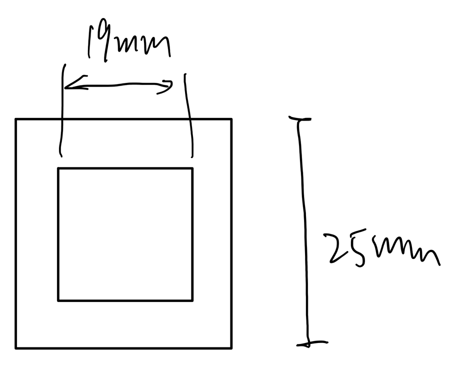
axial Force: $\frac{\sqrt{3}}{4}$ N

BMD





① Maximum bending moment is 112.5 N mm



$$\sigma_{avg} = \frac{My}{I}$$

$$I = \frac{1}{12}25^4 - \frac{1}{12}19^4 = 21692\,mm^4$$

$y = 12.5\,mm$

$$\sigma_{avg} = \frac{My}{I} = \frac{112.5\,Nmm \cdot 12.5\,mm}{21692\,mm^4} = 0.064828\,mpa$$

Stress concentration factor around the hole.

$$\frac{d}{H} = \frac{10.5}{25} = 0.42 \quad K_{tg} = 3.8$$

$$\sigma_{max} = K_{tg}\,\sigma_{avg} = 0.2463464\,Mpa$$

② Failure at the clamp:

shearing Force is 0.75N * Force of tie

$A = (25/2 - 3) \cdot 5 = 47.5\,mm^2$

$2A = 95\,mm^2$

$$\tau = \frac{F}{A} = \frac{0.75\,N}{95\,mm^2} = 0.00789\,mpa$$

Using von mises:

$$\sigma_{max} = \frac{\tau}{\sqrt{3}} = 0.004558\,Mpa$$

③ Failure at welding near clamp

ER70S6

↳ Tensile strength = 70 mpa

Subject to Bending moment 37.5 Nmm shear Force 0.75N

Axial force: $\frac{\sqrt{3}}{4}$N compression

④ Failure at welding near base beam

Subject to transverse load.

Safety factor: 3.

Yield strength of weld metal: 70 Mpa

$\frac{12.5}{\sqrt{3}} = \frac{x}{2}$

$x = \frac{25}{\sqrt{3}} = 14.43$

assume shear failure at throat area of the shorter weld.

$A = 0.707 \times 4 \times 14.43 = 40.80804\,mm^2$

Using distortion energy theory:

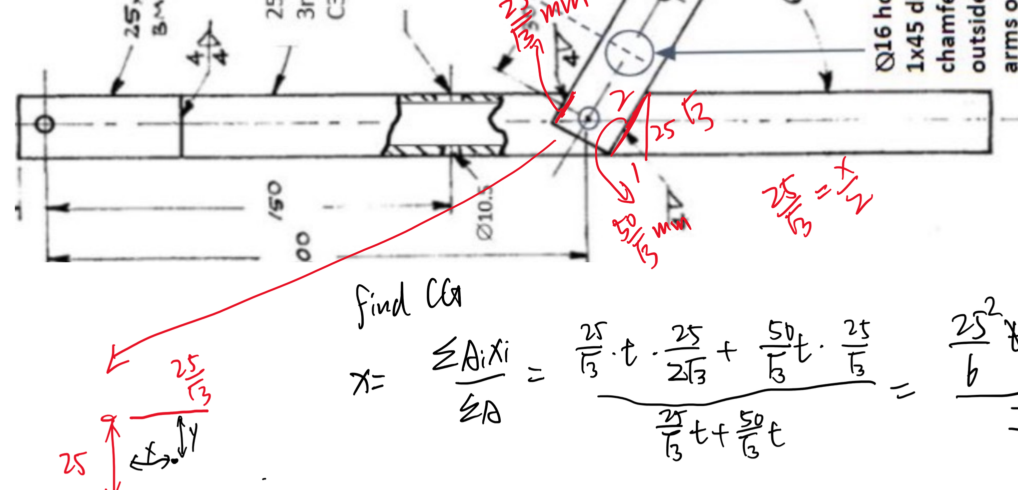
$S_{sy} = 0.58\,S_y = 0.58 \times 70 = 40.6\,mpa$

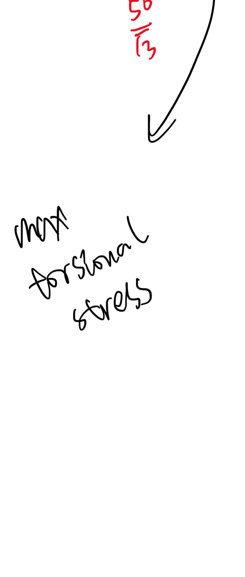
$$\sigma = \frac{F}{A} = \frac{0.5F}{40.80804} = 0.01225F \quad (mpa)$$

transverse force.

Subject to Torsional load:

Polar moment of Inertia





find CG

$$x = \frac{\Sigma A_i x_i}{\Sigma A} = \frac{\frac{25}{\sqrt{3}}t \cdot \frac{25}{2\sqrt{3}} + \frac{50}{\sqrt{3}}t \cdot \frac{25}{\sqrt{3}}}{\frac{25}{\sqrt{3}}t + \frac{50}{\sqrt{3}}t} = \frac{\frac{25^2}{6}\cancel{t} + \frac{2\times 25^2}{3}\cancel{t}}{\frac{75}{\sqrt{3}}\cancel{t}} = \frac{\frac{25^2}{6}\sqrt{3} + \frac{4\times 25^2}{6}\sqrt{3}}{75}$$

$$= \frac{\frac{5}{6}25^2\sqrt{3}}{75}$$

$$= 6.94\sqrt{3}$$

$$y = \frac{\Sigma A_i y_i}{\Sigma A} = 0 + 0 = 0$$

max torsional stress

$$J = \Sigma\,(I_x + I_y) \quad (I_y \to 0)$$

$$= \frac{(\frac{25}{\sqrt{3}})^3 t}{12} + \frac{50}{\sqrt{3}}t\,(\frac{50}{2\sqrt{3}} - 6.94\sqrt{3})^2 + \frac{25}{\sqrt{3}}t\,(\frac{25}{2\sqrt{3}} - 6.94\sqrt{3})^2 + \frac{(\frac{50}{\sqrt{3}})^3 t}{12}$$

$$= 250.58t + 168.13t + 333.05t + 2004.68t = 2756.45t\ mm^4$$

$$\sigma_{Torsional\ stress} = \frac{Tr}{J} = \frac{T \cdot 16.4\,mm}{2756.45 \cdot 4\,mm^4} = 0.00148742\,T \quad (mpa)$$

Relate it to the force on tie. $T = 100F$

$$\sigma_{Torsional} = 0.00148742 \cdot 100F = 0.148742F$$

Total shear due to transverse force and torsional:

$$\sigma_{Total} = 0.148742F + 0.01225F = 0.16099F$$

$\sigma_{ssy} = 40.6\,mpa.$

$\rightarrow \quad 0.3325295F < 40.6\,mpa$

$F < 122N$

Double part the $2F = 244N$