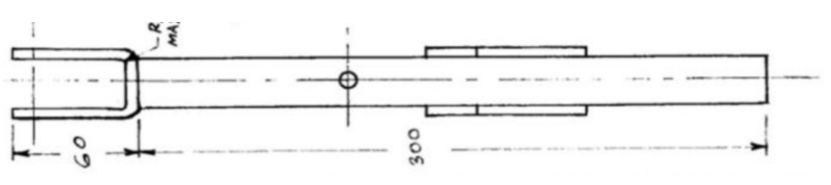
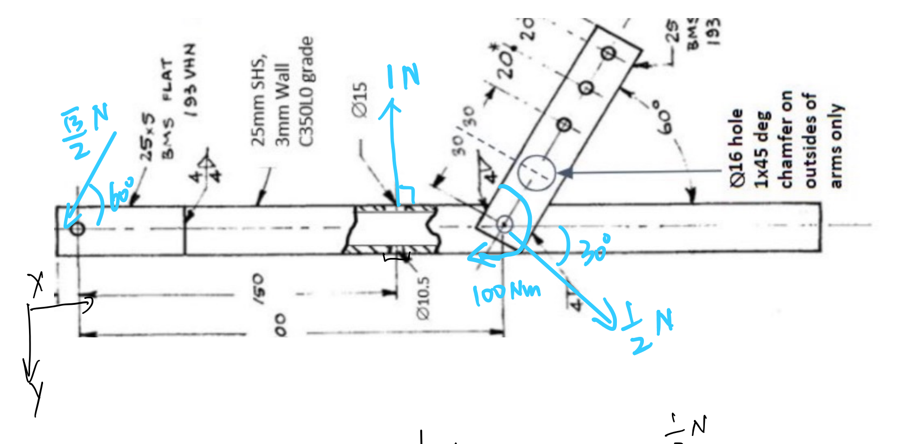
Base calculation version 3

2020年9月28日 星期一 23:52

Assume Force on Tie is 1N or P in some calculation





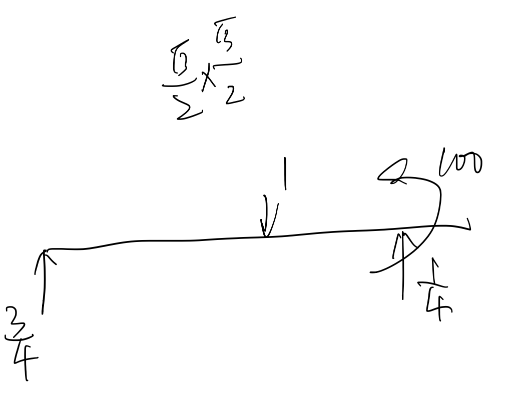
$\sin 60° = \frac{\sqrt{3}}{2}$

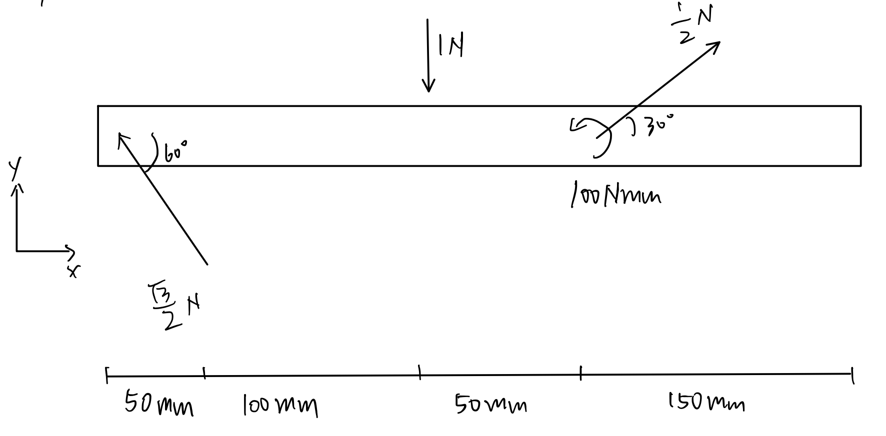
$\sin 30° = 0.5$

$\cos 30° = \frac{\sqrt{3}}{2}$

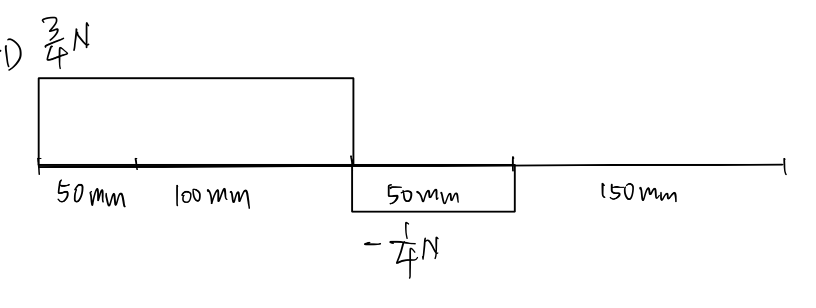
$\cos 60° = 0.5$

$\frac{\sqrt{3}}{2} \times \frac{\sqrt{3}}{2}$



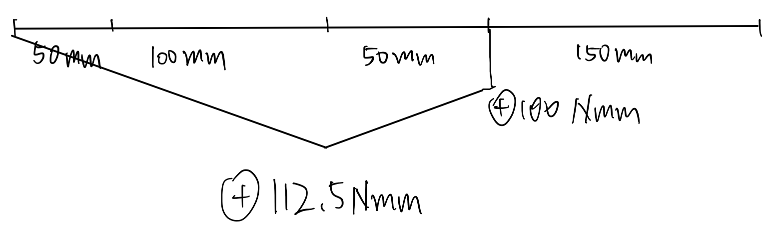


SFD $\frac{3}{4}$N



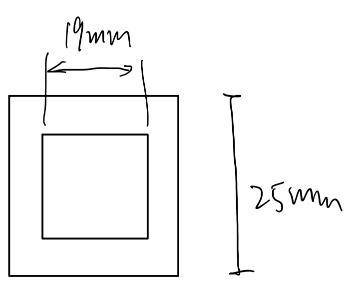
axial Force: $\frac{\sqrt{3}}{4}$N

BMD



2x7

① Maximum bending moment is 112.5 N mm



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

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

$y = 12.5\,mm$

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

stress concentration factor around the hole.

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

for C350L0 steel, yield stress: 350 mpa

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

allowed P: $0.2463P < 350$

$P < 1438\,N$ → most likely to fail in four location.

② Failure at the clamp:

shearing Force is 0.75N * Force of tie.

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

$2A = 95\,mm^2$

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

Using von mises:

$$\sigma_{max} = \frac{\tau}{\sqrt{3}} = 0.004558P\,mpa \qquad 0.004558P < 350 \Rightarrow P < 76788.06\,N$$

③ Failure at welding near base beam

Subject to transverse load.

Safety factor: 3.

Yield strength of weld metal: 70 ksi ~ 482.63 mpa

assume shear failure at throat area of the shorter weld.

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

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

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

Using distortion energy theory:

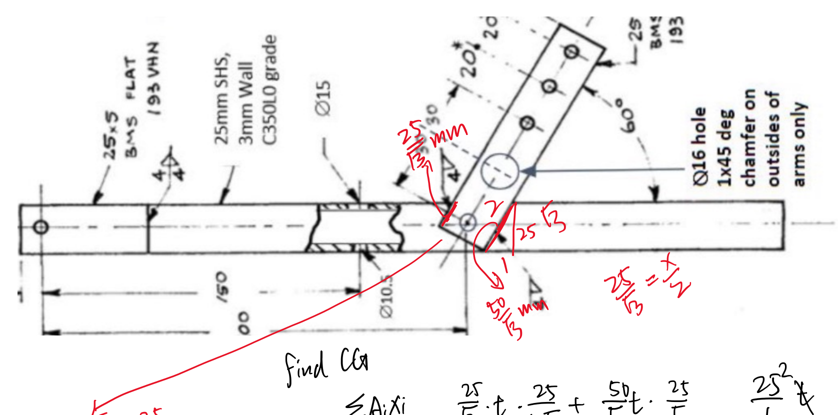
$$S_{sy} = 0.58\,S_y = 0.58 \times 482.63 = 279.92 \approx 280\,Mpa$$

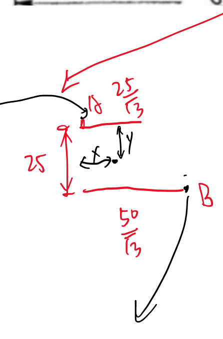
transverse force.

$$\sigma_{Transverse} = \frac{F}{A} = \frac{0.5P}{0.707 \times 25 \times 4 \div \sqrt{3}} = 0.00408P \quad (mpa)$$

Subject to Torsional load:

Polar moment of Inertia





max torsional stress

at here

find CG

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

$$= \frac{\frac{5}{6}25^2\sqrt{3}}{75} = 6.94\sqrt{3} = 12.02$$

$$y = \frac{\Sigma A_i y_i}{\Sigma A} = \frac{0 + \frac{50}{\sqrt{3}}t \cdot 25}{\frac{25}{\sqrt{3}}t + \frac{50}{\sqrt{3}}t} = 16.66$$

$$J = \Sigma(I_x + I_y)$$

$$= \frac{(\frac{25}{\sqrt{3}})^3 t}{12} + \frac{25}{\sqrt{3}}t\left[16.66^2 + (\frac{25}{2\sqrt{3}} - 6.94\sqrt{3})^2\right] + \frac{(\frac{50}{\sqrt{3}})^3 t}{12} + \frac{50}{\sqrt{3}}t\left[(25 - 16.66)^2 + (\frac{50}{2\sqrt{3}} - 6.94\sqrt{3})^2\right]$$

$$= 250.58t + 2004.68t + 4339.21t + 2176.02t = 8771t\,mm^4$$

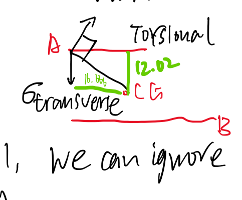
$h = 4\,mm \qquad t = \frac{\sqrt{2}}{2}h = 2\sqrt{2}$

At A

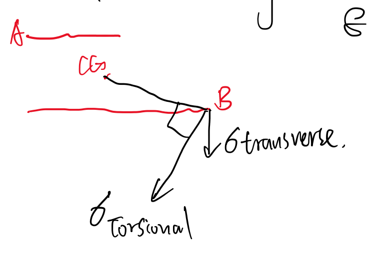
$$\sigma_{Torsional\ stress} = \frac{Tr}{J} = \frac{T \cdot 20.5435\,mm}{8771t\,mm^4} = 0.082829P \quad (mpa)$$

At B:

$$\sigma_{Torsional} = \frac{Tr}{J} = \frac{T \cdot 18.7988}{8771t} = 0.075788P\,(mpa)$$



$\sigma_{Total} =$



assumption: Since Transverse stress is too small, we can ignore it

max stress is 0.082829P at point A

$$\sigma_{Ssy} = 0.58 \cdot 482.63 = 280\,mpa$$

$$\rightarrow 0.082829P < 280\,mpa$$

$$P < 3380\,N$$

④ Failure at welding near clamp

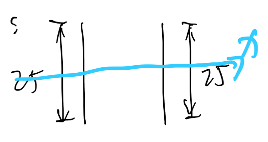
ER70S6

→ Tensile strength = 70 ksi 482.63 mpa

Subject to Bending moment 37.5 Nmm shear Force 0.75N

Axial force: $\frac{\sqrt{3}}{4}$N compression (ignored, because it is small) assumption

transverse stress:



$$\tau = \frac{V}{A} = \frac{0.75P}{50 \cdot t} = \frac{0.75P}{100\sqrt{2}} \quad Mpa$$

very small, we can ignore it → assumption

Area moment of Inertial about x-x axis:

$$I_x = 2 \cdot \frac{tl^3}{12} = 2 \cdot \frac{t\,25^3}{12} = 2 \cdot \frac{2\sqrt{2} \cdot 25^3}{12} = 7365.7\,mm^4$$

Bending stress:

$$\sigma = \frac{My}{I} = \frac{37.5 \cdot 12.5}{7365.7} = 0.06364P\,(mpa)$$

$$0.06364P < 280\,mpa$$

$$P < 4399.74\,N$$