Machine Design Course for Communication / Electrical Department

Sheet 3 – Design of Welding Joints

Problem 1

Two steel plates with Sy = 50 ksi are attached by parallel-loaded fillet welds, as shown in Figure P11.9. E60 series welding rods are used, and good welding practice is followed. Each of the welds is 3 in. long. With a safety factor of 3, what maximum tensile load can be applied?

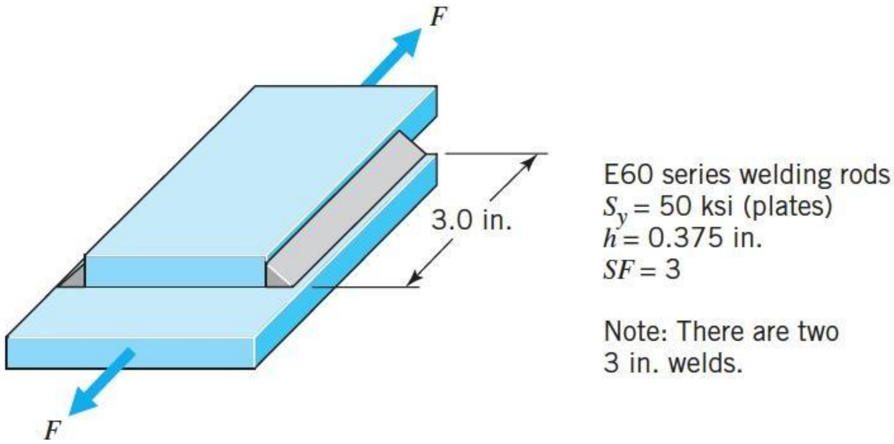
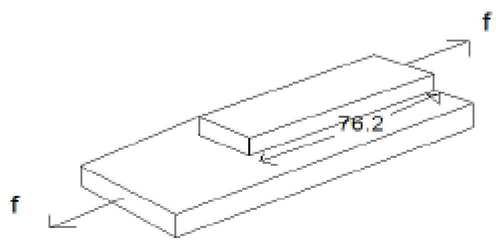


Figure 1.

Givens:

Sy = 50 ksi (pound per square inch)=344.73 Mpa

h=0.375 in =9.525 mm f.o.s=3



Req : Max. force (f)

Solution

$$\frac{F}{A} = \frac{Ssy}{SF}$$

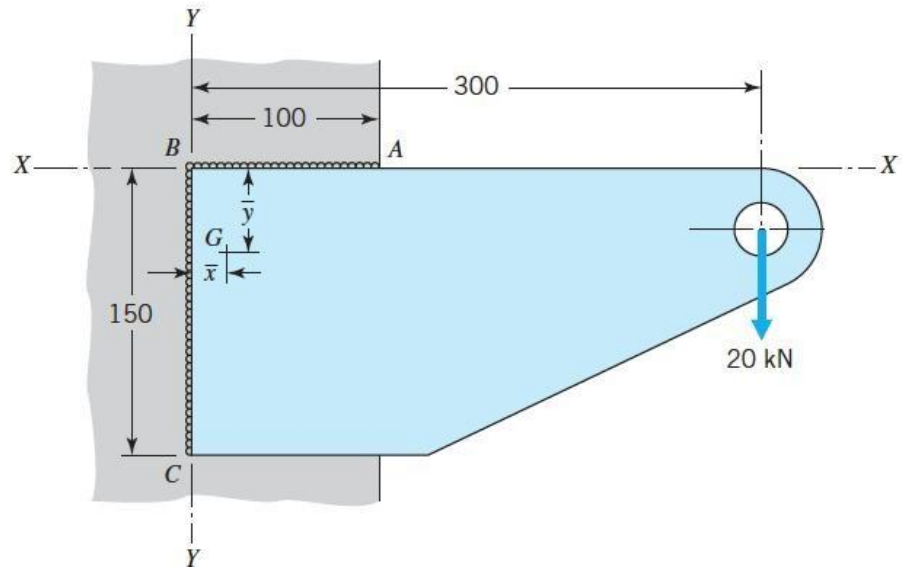
$$\frac{F}{2 * l * 0.707h} = \frac{0.5Sy}{SF}$$

$$\frac{F}{2 * 76.2 * 0.707 * 0.375} = \frac{0.5 * 344.73}{3}$$

F=2321.472 N

Problem 2

Determine the required weld size for Figure 2 using a welding rod of (Sy = 345 MPa) and a safety factor of 2.5 based on yielding.



Givens:

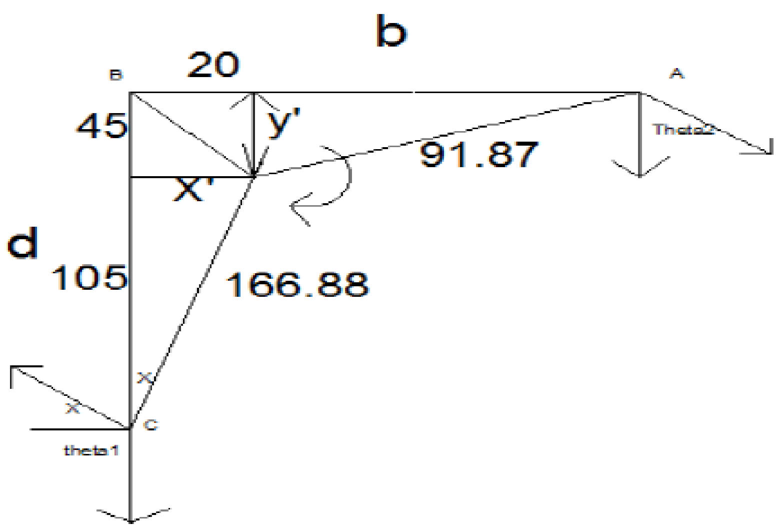
Sy = 345 Mpa

f.o.s=2.5

Solution

T=20*10^3*(300-X')= 20*10^3*(300-20)=5.6*10^6 N.mm

Point ©



$$x = \frac{b^2}{2(b+d)} = \frac{100^2}{2(100+150)} = 20$$

$$y = \frac{d^2}{2(b+d)} = \frac{150^2}{2(100+150)} = 45$$

$$Ju = \frac{(b+d)^4 - 6 * b^2 * d^2}{12(b+d)} = \frac{(100+150)^4 - 6 * 100^2 * 150^2}{12(100+150)} = 852.0833 * 10^3$$

$$\cos(x) = \frac{105}{106.88}$$

X=10.762°

Ra= $\sqrt{45^2 + 80^2} = 91.7877\ mm$

Cos(theta2)= $\frac{80}{91-78}$

$$z' = \frac{F}{A} = \frac{20 * 10^3}{(100+150) * 0.707h} = \frac{133.154}{h}$$

$$z'' = \frac{T * rc}{Ju * 0.707h} = \frac{5.6 * 10^6 * 106.88}{852.0833 * 10^3 * 0.707h} = \frac{993.53}{h}$$

$$z = \sqrt{z'^2 + z''^2 + 2z'z''\cos(theta1)}$$

$$= \sqrt{(\frac{133.154}{h})^2 + (\frac{993.53}{h})^2 + 2 * \frac{133.154}{h} * \frac{993.53}{h} * \cos(100.76)} = \frac{977.4}{h}$$

Point (A)

Z'= $\frac{133.154}{h}$

Z''= $\frac{T*ra}{Ju*0.707h} = \frac{5.6*10^6*91.7877}{852.0833*10^3*0.707h} = \frac{853.239}{h}$

$$z = \sqrt{z'^2 + z''^2 + 2z'z''\cos(theta1)}$$

$$= \sqrt{(\frac{133.154}{h})^2 + (\frac{853.239}{h})^2 + 2 * \frac{133.154}{h} * \frac{853.239}{h} * \frac{80}{91.78}} = \frac{969}{h}$$

Point B

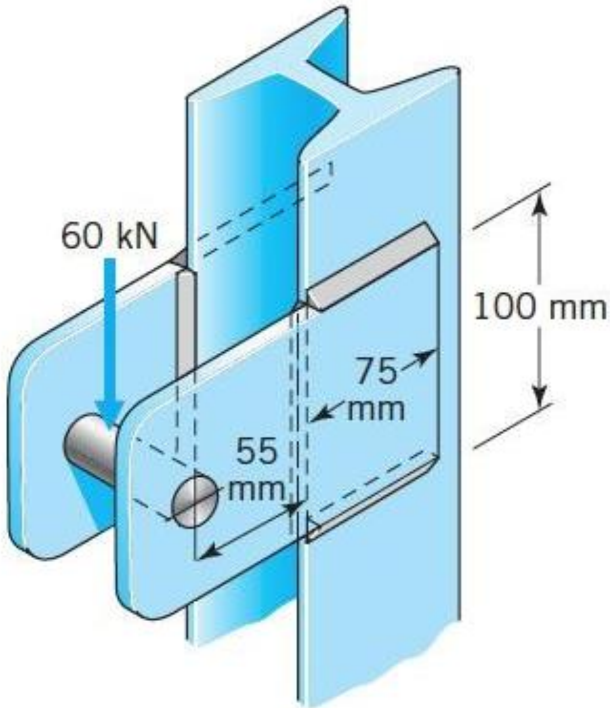
$$\frac{977.4}{h} = \frac{0.577 * Sy}{SF} = \frac{0.577 * 345}{2.5}$$

h=12.27 mm

Take h= 13 mm

Problem 3

The bracket shown in Figure 3 is to support a total load (equally divided between the two sides) of 60 kN. Using a welding rod of (Sy = 345 MPa) and a safety factor of 3.0, what size weld should be specified?



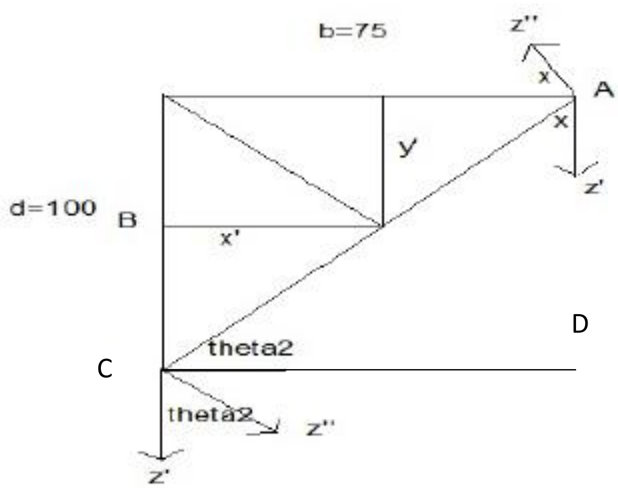
Note: Each plate has two 75 mm welds and one 100 mm weld.

Givens:

Sy = 345 Mpa

f.o.s=3

Solution



T=F/2*(55+X')= 30*10^3*(55+22.5)= 2.325*10^6 N.mm

X'=$\frac{b}{2b+d} = 22.5$

y'=$\frac{d}{2} = 50$

ra=$\sqrt{50^2 + (75-22.5)^2}$=72.5 mm

tan x=$\frac{75-22.5}{50}$

x=46.39^{o}

Ju=$\frac{8b^3+6bd^2+d^3}{12} - \frac{b^4}{2b+d} = 613.02 * 10^3\ mm^3$

Cos(theta2)=22.5/50

rc=$\sqrt{22.5^2 + 50^2} = 54.829$

Point A

$$z' = \frac{\frac{F}{2}}{A} = \frac{30 * 10^3}{2 * 75 * 0.707h} = \frac{169.73}{h}$$

$$z'' = \frac{T * ra}{Ju * 0.707h} = \frac{2.325 * 10^6 * 72.5}{613.02 * 10^3 * 0.707h} = \frac{388.925}{h}$$

$$z = \sqrt{z'^2 + z''^2 + 2z'z''\cos(theta1)}$$

$$= \sqrt{(\frac{169.73}{h})^2 + (\frac{388.925}{h})^2 + 2 * \frac{169.73}{h} * \frac{388.925}{h} * \cos(136.4)} = \frac{290.624}{h}$$

Point c

$$z'' = \frac{T * rc}{Ju * 0.707h} = \frac{2.325 * 10^6 * 54.829}{613.02 * 10^3 * 0.707h} = \frac{294.129}{h}$$

$$z = \sqrt{z'^2 + z''^2 + 2z'z''\cos(theta1)} = \sqrt{(\frac{169.73}{h})^2 + (\frac{294.129}{h})^2 + 2 * \frac{169.73}{h} * \frac{294.129}{h} * \frac{22.5}{50}}$$

$$= \frac{400.31}{h}$$

Point B

$$z'' = \frac{T * rb}{Ju * 0.707h} = \frac{2.325 * 10^6 * 22.5}{613.02 * 10^3 * 0.707h} = \frac{120.7011}{h}$$

$$z = z' + z'' = \frac{169.73}{h} + \frac{120.7011}{h} = \frac{290.43}{h}$$

Point c

$$\frac{400.31}{h} = 0.577 * \frac{345}{3}$$

h=6.023≡7 mm