College of Engineering & Technology

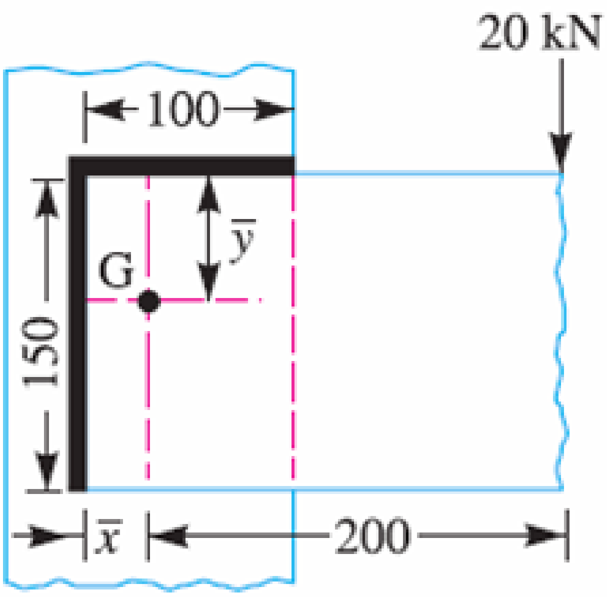
Department: Mechanical Engineering | Marks: 20
Lecturer: Dr. Rola Afify | Time: 11.00 - 12.00
Course Code: ME356 | Date: 30/12/2015

Name: R.N.:

Answer the following questions:

Question one (10 marks)

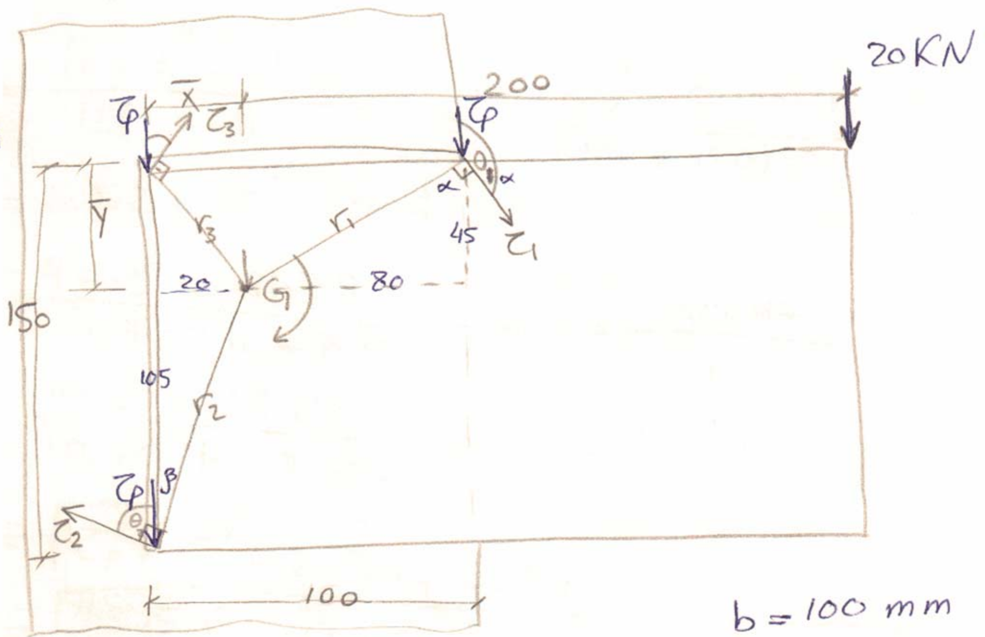
A welded joint subjected to an eccentric load of 20 kN, as shown in figure. The welding is only on one side. Determine the uniform size of the weld on the entire length of two legs (h). Take the allowable shear stress for the weld material is 80 MPa.



All dimensions in mm.

$h = ??$

$\tau_{all} = 80\,MPa$



من الجدول

$b = 100\ mm$

$d = 150\ mm$

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

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

$$A = 0.707\,h\,(b+d) = 0.707\,h\,(100+150)$$
$$= 176.75\,h$$

$$T = F\ell = (20 * 1000) * 200 = 4 * 10^6 \quad N\cdot mm$$

$$\tau_P = \frac{F}{A} = \frac{20*10^3}{176.75h} = \frac{113.15}{h}$$

من الرسم

$$r_1 = \sqrt{80^2 + 45^2} = 91.79 \quad mm$$

$$r_2 = \sqrt{20^2 + (150-45)^2} = 106.89 \quad mm$$

$$\alpha = \tan^{-1}\frac{80}{45} = 60.64^\circ$$

$$\theta_1 = 90 + \alpha = 150.64^\circ$$

$$\beta = \tan^{-1}\frac{20}{105} = 10.78^\circ$$

$$\theta_2 = 90 - \beta = 79.2^\circ$$

$$\tau_1 = \frac{Tr_1}{J} = \frac{T r_1}{0.707h\, J_u}$$

من الجدول

$$J_u = \frac{(b+d)^4 - 6b^2d^2}{12(b+d)} = \frac{(100+150)^4 - 6(100)^2(150)^2}{12\,(100+150)}$$

$$J_u = 8.52 * 10^5 \quad mm^3$$

$$\tau_1 = \frac{4*10^6 * 91.79}{0.707h * 8.52*10^5} = \frac{609.472}{h}$$

$$\tau_2 = \frac{4*10^6 * 106.89}{0.707h*8.52*10^5} = \frac{709.73}{h}$$

$$\tau_{max1} = \sqrt{\tau_P^2 + \tau_1^2 - 2\tau_P\tau_1 \cos\theta_1}$$

$$= \sqrt{\left(\frac{113.15}{h}\right)^2 + \left(\frac{609.472}{h}\right)^2 - 2\left(\frac{113.15}{h}\right)\left(\frac{609.472}{h}\right)\cos 150.64}$$

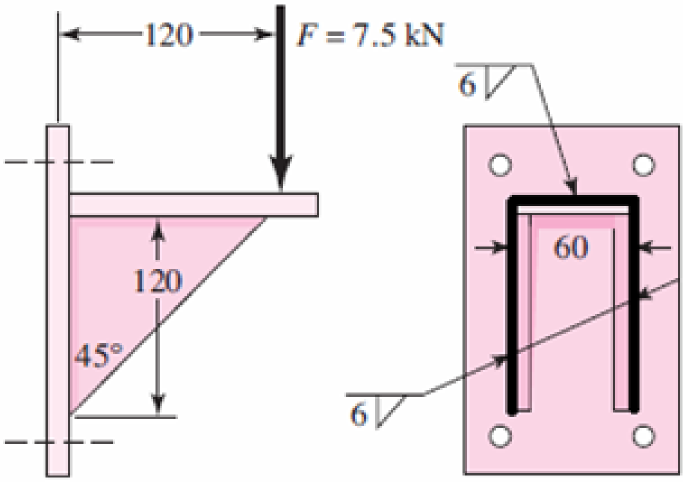
$$= \frac{710.26}{h}$$

$$\tau_{max2} = \sqrt{\left(\frac{113.15}{h}\right)^2 + \left(\frac{709.73}{h}\right)^2 - 2\left(\frac{113.15}{h}\right)\left(\frac{709.73}{h}\right)\cos 79.2}$$

$$= \frac{697.44}{h}$$

Question two (10 marks)

The figure shows a welded steel bracket loaded by a static force *F*. Estimate the factor of safety if the yield strength in the weld throat is 240 MPa.



Dimensions in millimeters

from table & figure

$h = 6\ mm$

$b = 60 mm$

$d = 120\ mm$

$$\bar{X} = \frac{b}{2} = \frac{60}{2} = 30\ mm$$

$$\bar{Y} = \frac{d^2}{b+2d} = \frac{(120)^2}{6+2*120} = 48 mm$$

$$A = 0.707h(b+2d) = 0.707*6*(60+2*120)$$

$$= 1272.6\ mm^2$$

$$I_u = \frac{2d^3}{3} - 2d^2\bar{Y} + (b+2d)\bar{Y}^2$$

$$= \frac{2(120)^3}{3} - 2(120)^2*48 + (60+2*120)*(48)^2$$

$$= 460800\ mm^4$$

$$\tau' = \frac{F}{A} = \frac{7.5*10^3}{1272.6} = 5.89\ MPa$$

$$\bar{Y} < d-\bar{Y}$$

$$48 < 120-48 = 72\ mm$$

$$\sigma_b = \frac{MY}{I} = \frac{(7.5*10^3*120)*72}{0.707h\ I_u} = 33.15 MPa$$

$$\tau_{max} = \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + \tau'^2} = \sqrt{\left(\frac{33.15}{2}\right)^2 + 5.89^2} \leq \frac{0.5\ S_y}{f.s.}$$

$$f.s. \leq \frac{0.5*240}{17.52} \quad \therefore f \leq 6.82$$

$$\sigma_{max} = \frac{\sigma_b}{2} + \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + \tau'^2} = \frac{33.15}{2} + \sqrt{\left(\frac{33.15}{2}\right)^2 + 5.89^2} \leq \frac{S_y}{f.s.}$$

$$f.s. \leq \frac{240}{34.17} \quad \therefore f.s. \leq 7.02$$

$\therefore$ the max. factor of safty $= 6.82$