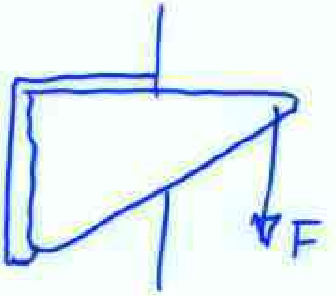
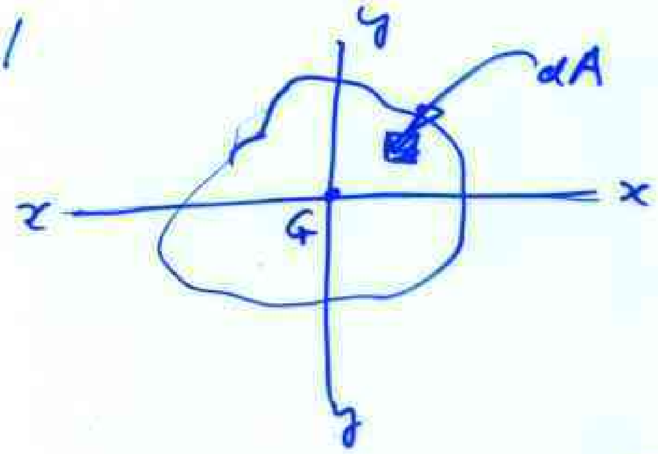
D&P	MEEN 3004	1999-2001
	3010	2002 2003
Materials	MEEN-3011	2002-2003
	MEEN-3005	1999-2001

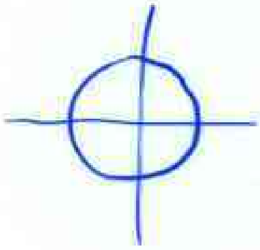


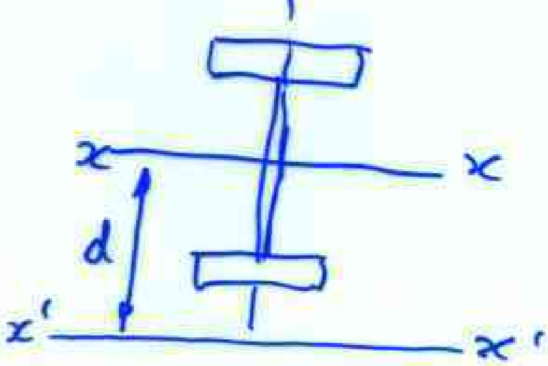
1



$$I_x = \int y^2 dA$$

$$I_y = \int x^2 dA$$





I_x Biggest

I_y less so

$I_{\text{ANOTHER axis}} \parallel x \qquad I_{Gx} + Ad^2$

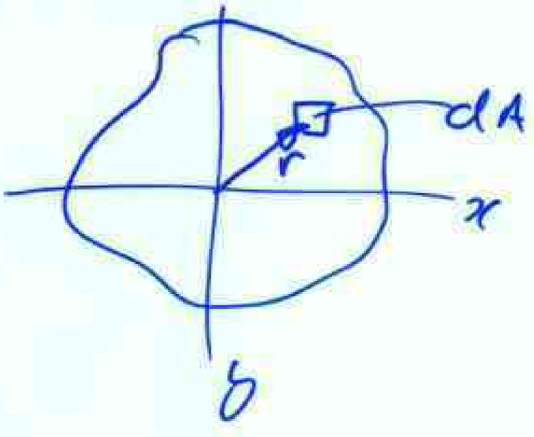
d is distance between new axis & x-axis

$$J = \int r^2 dA$$

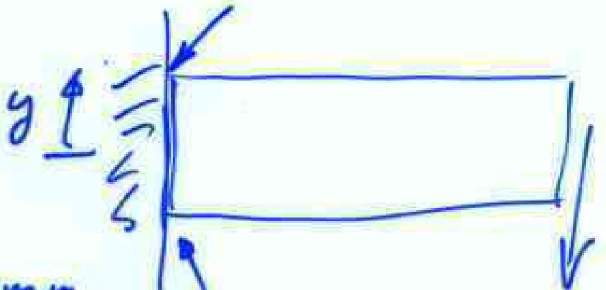
$$r^2 = x^2 + y^2$$

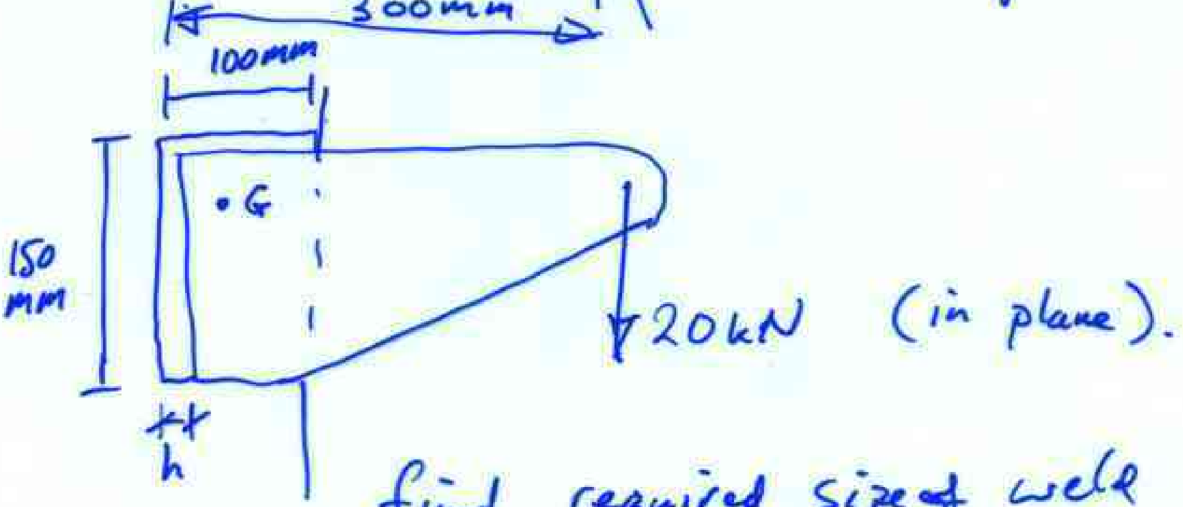
$$J = \int x^2 + y^2 \, dA$$

$$= I_x + I_y$$



TORSION			BENDING	
Direct shear	$\frac{P}{A}$	→	same	
Torsion induced shear	$\frac{Tr}{J}$		Bending induced ~~shear~~ stress	$= \frac{My}{I}$

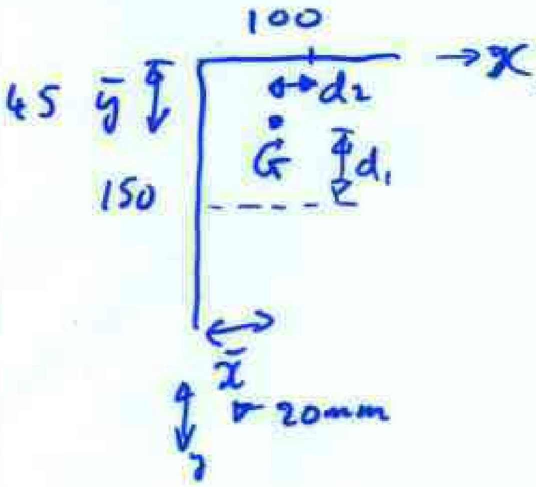




find required size of weld

for $S_y = 345$ MPa

F.S. = 2·5



$$\bar{x} = \frac{\Sigma x_i A}{\Sigma A_i} = \frac{(100t)(50) + (150t)(0)}{(250t)}$$

$$= 20\text{ mm}$$

$$\bar{y} = \frac{\Sigma y_i A_i}{\Sigma A_i} = \frac{(100t)(0) + (150t)(75)}{250t}$$

$$\bar{y} = 45\text{ mm}$$

Need to know J for weld group.

$$J = I_x + I_y$$

look @ each arm of weld seporately.

longer $J_L = [I_x] + [I_y]$

$$\left[I_x = \frac{1}{12}AL^2\right] \quad = \left[\frac{L^3 t}{12} + Lt\,\overbrace{(75-45)^2}^{d_1^2}\right] + \left[Lt(20)^2\right]$$

$$J = 476250t$$

shorter $J = I_x + I_y$

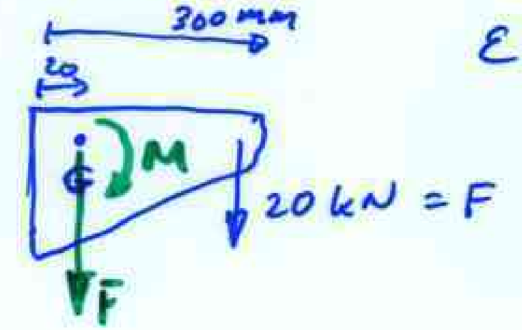
$$= \left[(100t)(45)^2\right] + \left(\frac{100^3 t}{12} + (100t)\overset{d_2^2}{(50-20)^2}\right]$$

$$J_s = 375833t$$

$$J_{TOTAL} = (375833 + 476250)t$$

$$= \underline{852083t}$$

Express LOAD as a force plus a moment.



Effect @ G of F

is Force $\underline{20kN}$

+ moment of

(20kN)(300-20 mm)

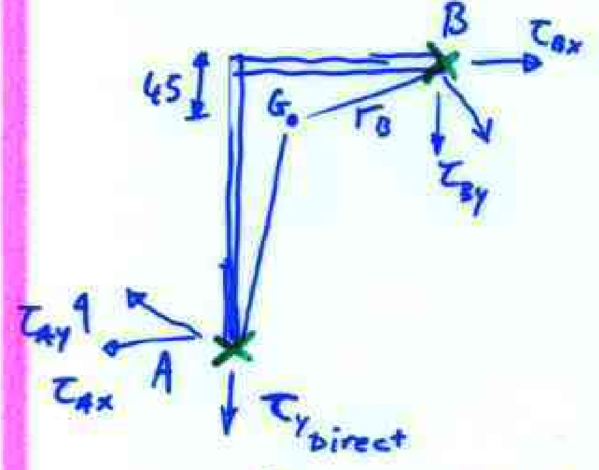
$M = 5600$ Nm

Direct Sheor $= \frac{F}{A} = \frac{20\,000}{(250)(t)} = \underbrace{\frac{80}{t}\text{ MPa}}_{\text{constant everywhere}}$

Sheor Due to Torque

$$\tau = \frac{Tr}{J} \qquad \tau_{Bx} = \frac{(45)(5600)}{852083t} = \frac{295.7}{t}\text{ MPa}$$

$$\tau_{By} = \frac{(100-20)(5600)}{\underbrace{852083t}_{J}} = \frac{525.8}{t}\text{ MPa}$$



$$\tau_{Ax} = \frac{(150-45)(5600)}{J} = \frac{690}{t}\text{ MPa}$$

$$\tau_{Ay} = \frac{(20)(5600)}{J} = \frac{131}{t}\text{ MPa}$$

Max occurs @ $\underline{A}$ (check for yourself B smaller)

$$\frac{1}{t}\sqrt{690^2 + (131-80)^2} = \boxed{\frac{692}{t}}\text{ MPa}$$

@B

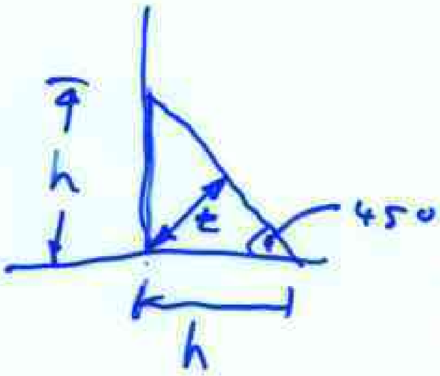
$$\frac{1}{t}\sqrt{(525.8+80)^2+(295.7)^2} = \frac{674.1}{t} \quad \text{(smaller)}.$$

Look @ failure @ point A

$$\frac{692}{t} = \frac{(\overset{\text{Because SHEAR}}{0.58})(345)}{\underset{\text{F.S.}}{2.5}}$$

$t = 8.65\text{mm}$

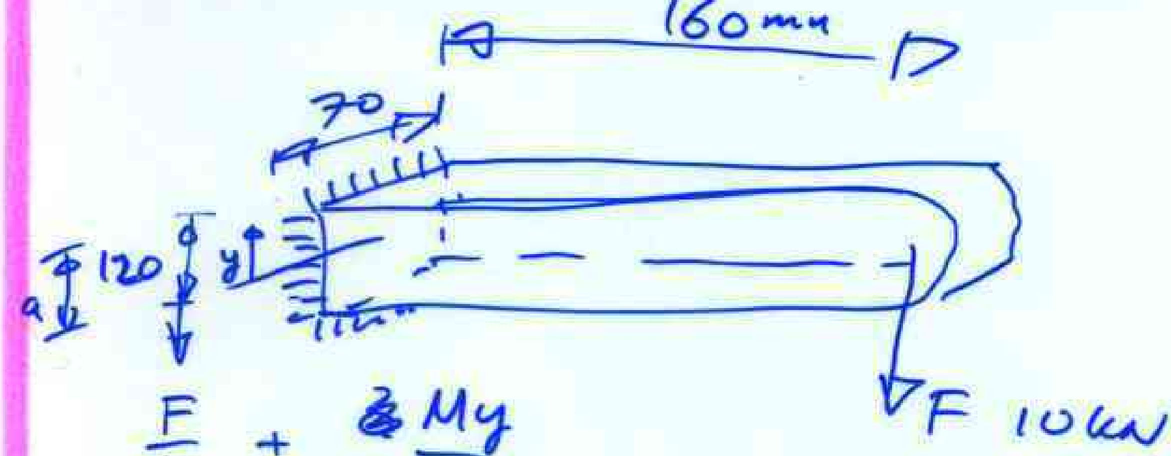
$$h = \frac{t}{\cancel{\sqrt{}}\,0.707}$$



$$0.707 = \frac{\sqrt{2}}{2}$$

$$h = \frac{8.65}{0.707} = 12.23\text{ mm}$$

$\boxed{h = 13\text{ mm}}$ ← useful spec.



$$\frac{F}{A} + \frac{My}{I}$$

Bending moment

$$(160\times10^{-3})(10\times10^{3}) = 1600NM$$

$I_{x\,vert\,welds}$. $2\left(\frac{L^3t}{12}\right) = 2(144\times10^{-9}t)\ m^4$

120 mm

$I_{x\,Hz}$ welds. $2Lta^2 = (2)(70)(t)(60^2)$

$2(252\times10^{-9}t)\ m^4$

$I_{x_{total}} = I_{x_{vert}} + I_{x_{Hz}}$

then you have M, I, y

calc stresses.

Ans. $t = 1.86\ mm$

$h = \sim 3mm.$

if $\boxed{\sigma_y = 345MPa}$