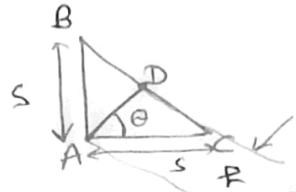
Throat

- Minimum cross-section/plane of weld located at 45° to the leg dimension. [in case of PFW]
- Throat thickness represents the thickness of weld where failure is occurring (i.e. where stress induced is maximum)
- Fillet welds → specified by the size on leg of fillet weld.

$AB = AC = s$ = size on leg of fillet weld

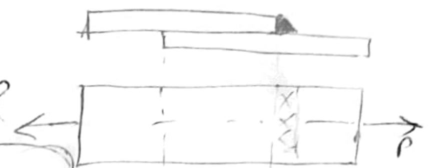
h → throat thickness



Cross-section of fillet weld

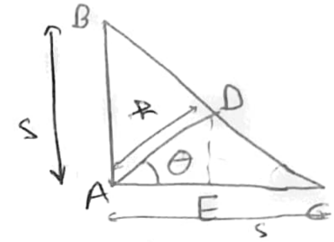
⇓

Consists of an approximately triangular cross-section joining two surfaces at right angles to each other.



Transverse

Parallel.



$AC = AE + CE$

$= h\cos\theta + DE$

$s = h[\cos\theta + \sin\theta]$

$A_{FW} = h\,L_e$

$$A_{FW} = \left(\frac{s}{\cos\theta + \sin\theta}\right) L_e$$

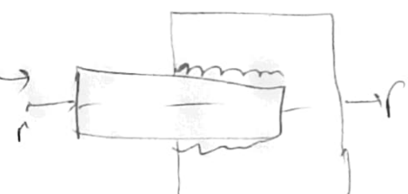
for single fillet, $L_e = l$

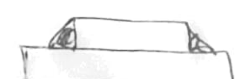
for double fillet, $L_e = 2l$

$$(\tau_{max})_{FW} = \frac{P_s}{A_s}$$

$$= \frac{P_s}{\left(s/\cos\theta + \sin\theta\right) L_e}$$

$$(\tau_{max})_{FW} = \frac{P_s(\cos\theta + \sin\theta)}{s L_e}$$

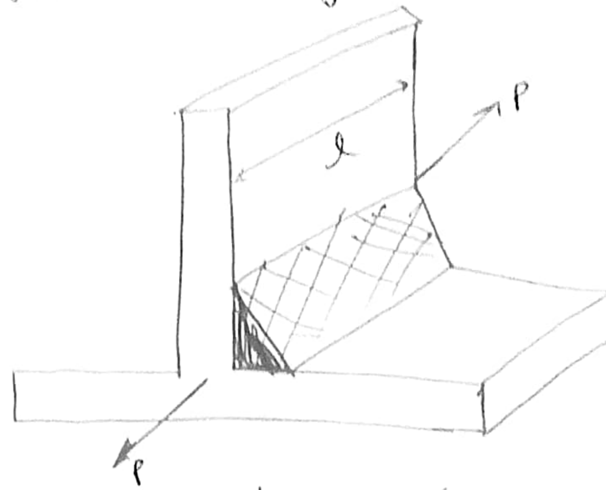




- Size of weld is specified by leg length (s)

...allel fillet weld

- Load is acting ∥ to length of weld (direcⁿ of weld)



- In case of PFW, location of throat plane will be 45° to the leg dimension(s)

Safe condⁿ, $(\tau_{max})_{ind} \leq \tau_{per}$

$$\frac{P_s}{A_{PFW}} \leq \tau_{per}$$

τ_{per} → Permissible shear stress for the weld (N/mm²)

$$\frac{P}{0.707\,l\,e\,s} \leq \tau_{per}$$

$$\boxed{P \leq 0.707\,s\,l\,e\,\tau_{per}}$$

⇓

strength eqn of PFW.

location of throat plane

$$\frac{d\tau_{max}}{d\theta} = 0$$

$$\frac{d}{d\theta}\left[\frac{P}{s\,l\,e}(\sin\theta + \cos\theta)\right] = 0$$

$$\tan\theta = 1$$

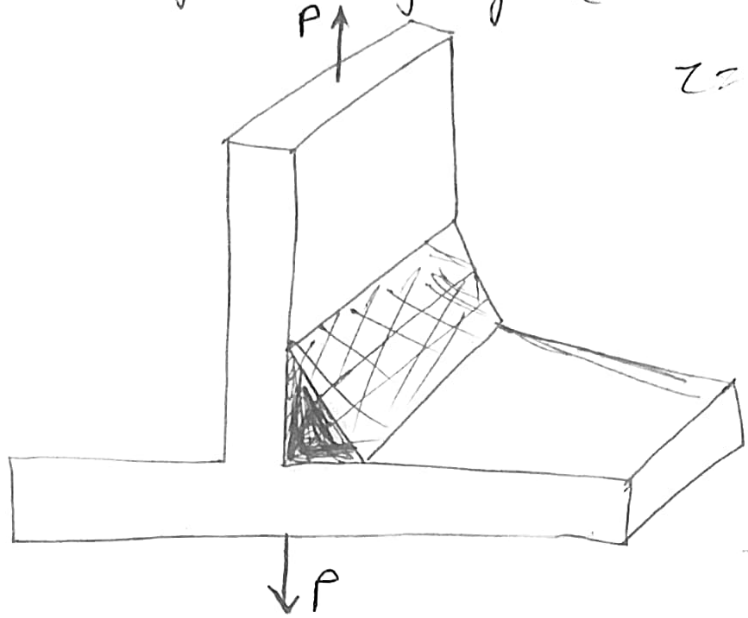
$\boxed{\theta_{PFW} = 45°}$ ⇒ condⁿ for plane with maximum shear stress

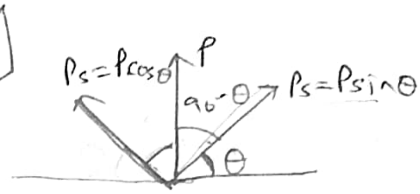
ransverse fillet weld

Load is acting ⊥ to length of weld

$$t = \frac{h}{\sin\theta + \cos\theta}$$

$$\tau = \frac{P\sin\theta}{t\,l}$$





Normal force along the throat plane is neglected

$$\frac{d}{d\theta}\left[\frac{P_s}{s l_e}(\cos\theta + \sin\theta)\right] = 0$$

$$\frac{d}{d\theta}\left[\frac{P\sin\theta}{s l_e}(\cos\theta + \sin\theta)\right] = 0$$

$$\frac{P}{s l_e}\frac{d}{d\theta}\left[\sin\theta(\cos\theta + \sin\theta)\right] = 0$$

$$\tan 2\theta = -1$$

$$\boxed{\theta_{TFW} = 67\tfrac{1}{2}^\circ}$$ ⇒ cond^n for plane with max shear stress

$$A_{TFW} = \left(\frac{s}{\cos\theta + \sin\theta}\right) l_e$$ → R

$$\boxed{A_{TFW} = 0.765\, s l_e}$$

for TFW, $(\tau_{max})_{ind} \le \tau_{per}$

$$\frac{P\sin\theta}{0.765\, s l_e} \le \tau_{per}$$

$$\boxed{P \le 0.828\, s l_e \tau_{per}}$$ } strength of TFW

As per AWS, $\boxed{P \le 0.832\, s l_e \tau_{per}}$

mmany

throat thickness

$$t_{PFW} = \frac{s}{\sqrt{2}} = 0.707s$$

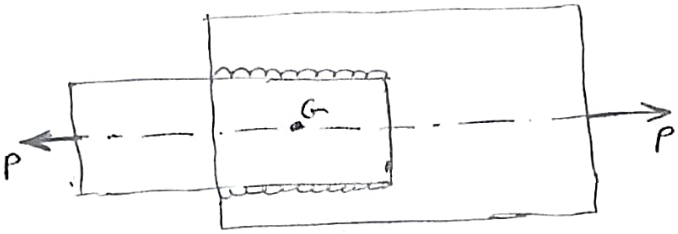
$$t_{TFW} = 0.765s$$

for a given dimension of weld & material,

$$\frac{\text{Strength of TFW}}{\text{Strength of PFW}} = \frac{0.832}{0.707} = 1.176 \approx 1.18$$ (18% more stronger)

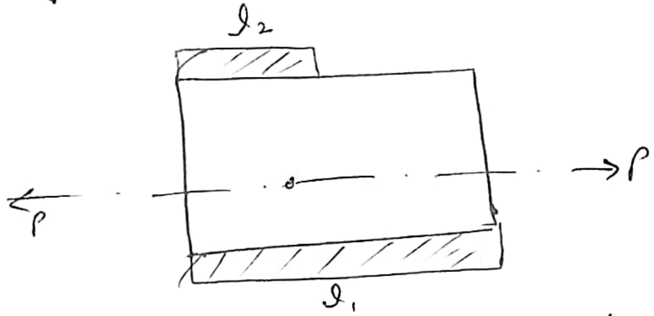
- In the design of fillet welds, if unless otherwise mentioned, it is better to assume the fillet weld as a ||el fillet weld becoz it is worst weld in comparison to TFW.
- For designing, we assume that plane of maximum shear for both welds (||el & transverse) lies at 45° to the leg dimension.

...ded Joint

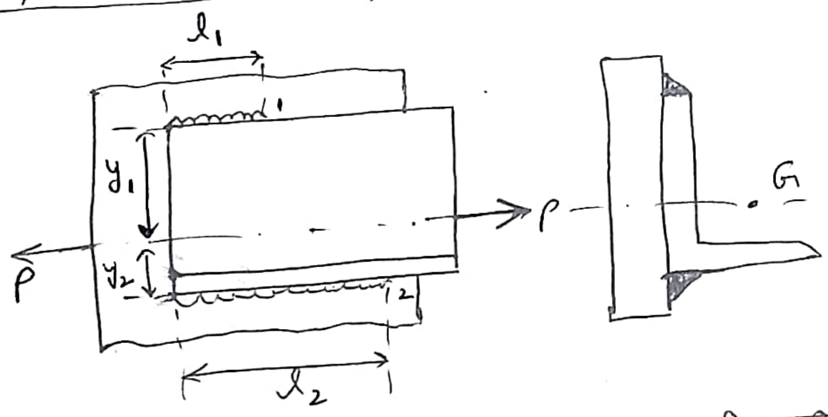


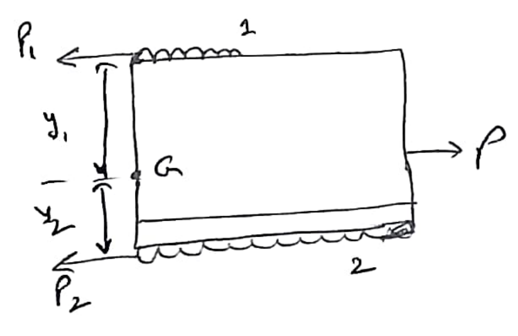
⇒ Here length of weld will be same becoz force is passing through CG of group of welds

Objective is to adjust the value of l_1 & l_2 in such a way that the CG of group of weld must ~~pass~~ lie on the LOA of force.



Unsymmetrical double parallel fillet weld





~~$P_1 = 0.707$~~

$$P_1 = 0.707\, s\, l_1\, \tau_{max}$$

$$P_2 = 0.707\, s\, l_2\, \tau_{max}$$

$$\Sigma F_x = 0$$

$$P = P_1 + P_2$$

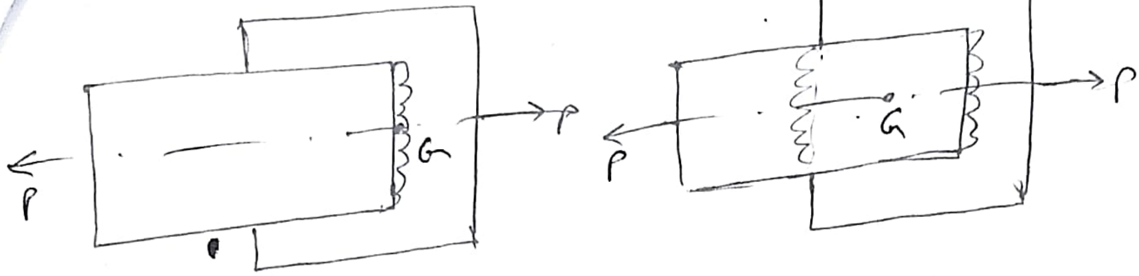
$$P = 0.707\, s\,(l_1 + l_2)\, \tau_{max}$$

$$\Sigma M_G = 0$$

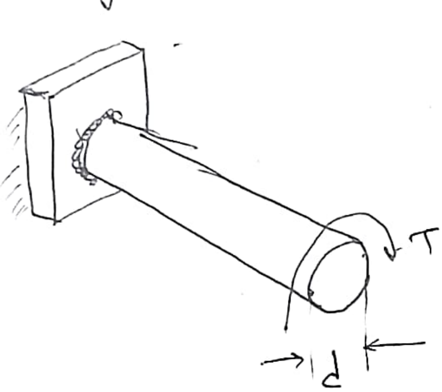
$$P_1 y_1 = P_2 y_2$$

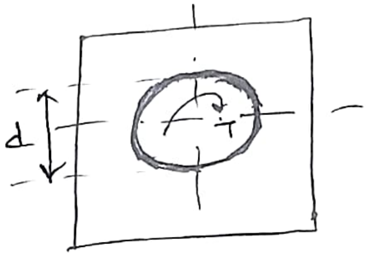
$$\boxed{l_1 y_1 = l_2 y_2}$$

Transverse fillet weld

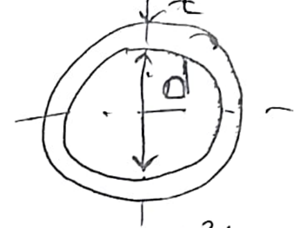


Circular fillet weld subjected to torsion





Annular fillet weld



$$\tau_{max} = \frac{T r_{max}}{J}$$

$$I = \frac{\pi d^3 t}{8}$$

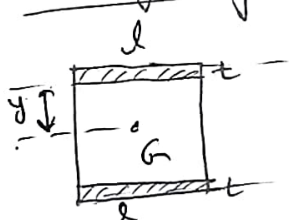
$$J = \frac{\pi d^3 t}{4}$$

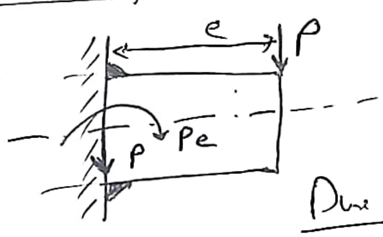
(if $t << d$)

$$\tau_{max} = \frac{T \cdot d/2}{(\pi d^3 t/4)}$$

$$\boxed{\tau_{max} = \frac{2T}{\pi d^2 t}}$$

Rectangular fillet subjected to ~~tor~~ B.M.

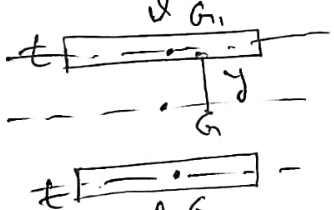




$$\boxed{\tau = \frac{P}{2tl}}$$ (Due to P)

Due to P.e

$$\sigma_b = \frac{M y_{max}}{I} = \frac{(Pe)y}{I}$$



$$I_{G_1} = \frac{l t^3}{12}$$

$$I_G = I_{G_1} + A (GG_1)^2$$

$$= \frac{l t^3}{12} + l t \cdot y^2$$

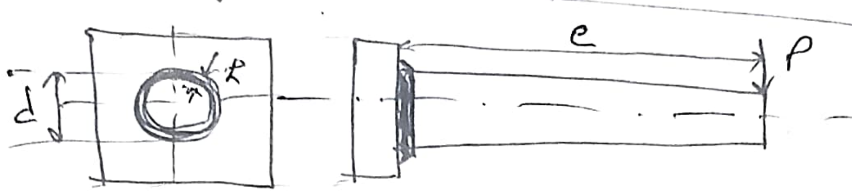
$$I = 2 I_G$$

$$= \cancel{\frac{l t^3}{6}} + l t y^2 = 2 l t y^2$$

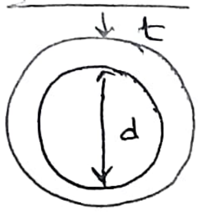
$$\tau_{max} = \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + \tau^2} \quad (MSST)$$

(Assuming fillet weld fails under shear)

Circular fillet weld subjected to bending



Due to P:



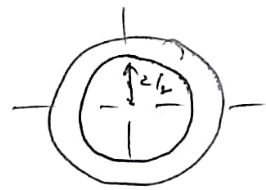
$t << d$

$$\tau = \frac{P}{A_{throat}}$$

$$\boxed{\tau = \frac{P}{\pi d t}}$$

$$\boxed{I = \frac{\pi d^3 t}{8}}$$

Due to Pe



$$\sigma_b = \frac{M y_{max}}{I}$$

$$\boxed{\sigma_b = \frac{(Pe)\, d/2}{I}}$$

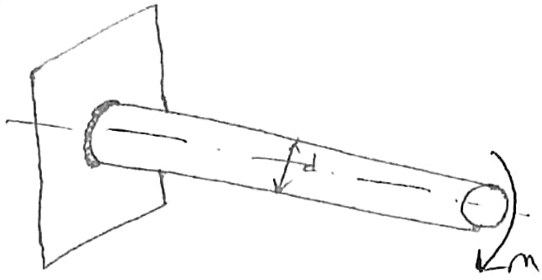
$$\boxed{\sigma_b = \frac{4Pe}{\pi d^2 t}}$$

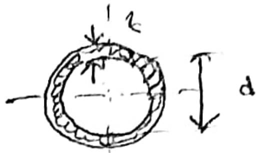
$$\boxed{\tau_{max} = \sqrt{\left(\frac{\sigma_b}{2}\right)^2 + \tau^2}}$$

$$\tau = \frac{10 \times 1000}{\pi \times 50 \times t} = \frac{63.694}{t}$$

$$\sigma_b = \frac{4 \times 10 \times 1000 \times 200}{\pi \times (50)^2 \times t} = \frac{1019.108}{t}$$

ircular fillet welds under pure bending



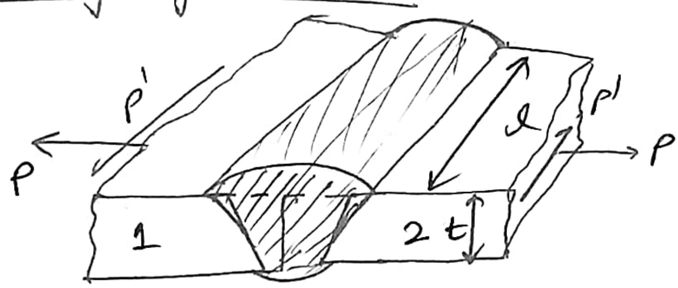


$$\sigma_b = \frac{M}{Z_W} = \frac{M\, y_{max}}{I}$$

$$y_{max} = d/2 \qquad I = \frac{\pi d^3 t}{8}$$

$$\boxed{\sigma_b = \frac{M \cdot d/2}{\pi d^3 t/8} = \frac{4M}{\pi d^2 t}}$$

Strength of butt Joint



t = min. thickness of weld (throat thickness)

$$\sigma_{max} = \frac{P}{tl} \qquad \tau_{max} = \frac{P}{tl}$$

$$\boxed{P = tl\,\sigma_{max}} \qquad \boxed{P = tl\,\tau_{max}}$$

Here t = plate thickness

$\boxed{\sigma_{max} \text{ or } \tau_{max}}$ ⇒ Permissible stresses for the weld material.

$$\therefore \boxed{P = tl\,\sigma_{per}} \ \& \ \boxed{P = tl\,\tau_{per}}$$