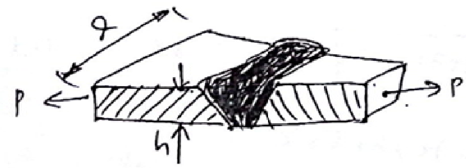
Design of Butt welds:

Single V butt Joint:



h – weld size

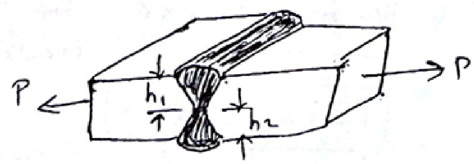
l = length of weld = width of Plate

σ = Allowable or working stress of the weld.

P = Stress × Area

$= \sigma \times h \times l$

Double V-butt Joint:



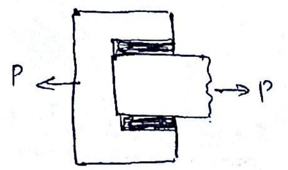
$P = \sigma (h_1 + h_2) \times l$

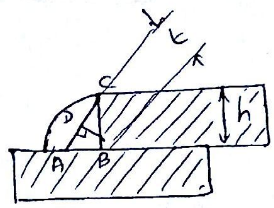
Design of fillet weld:

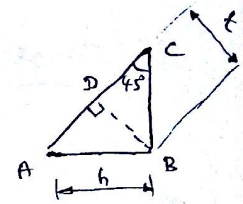
Two types of fillet weld:

(i) Longitudinal (or) Parallel fillet weld
(ii) Transverse fillet weld

Parallel fillet weld:







AB = BC = h = size of weld.

BD which is ⊥r to AC, is called 't' throat thickness.

In △ BDA,

$$\frac{BD}{AB} = \sin\theta$$

$$BD = AB\sin\theta = AB\sin 45 = h \times 0.707$$

$$t = 0.707h$$

Shear strength = $A \times \tau$

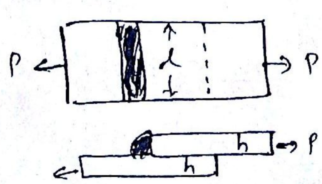
$$P = 0.707h \times l \times \tau$$

$$\boxed{P = 0.707h \times l\tau}$$ for single Parallel fillet

$$P = 2 \times 0.707h \times l \times \tau$$

$$\boxed{P = 1.414\, h \times l \times \tau}$$ for double Parallel fillet

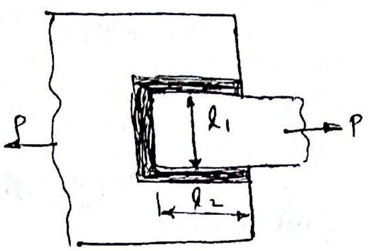
Transverse fillet:



$$\boxed{P = 0.707h \times l \times \sigma}$$ for single Transverse fillet

$$\boxed{P = 1.414\, h \times l \times \sigma}$$ for double Transverse fillet

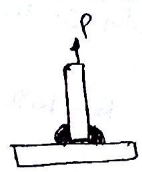
Combination of Transverse and Parallel fillet weld:



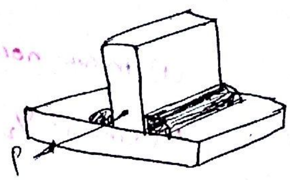
$P = P_{transverse} + P_{Parallel}$

$= 0.707 h l_1 \sigma + 1.414 h l_2 \tau$

Design of T-Joint:



$P = 1.414 h l \sigma$



$P = 1.414 h l \tau$

Note:

The design strength equations for various types of welded joints for different loading conditions are given in

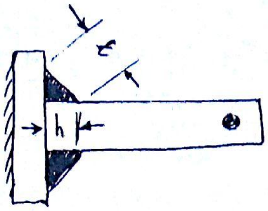
PSGDB, P. No : 11.3

Eccentrically loaded welded Joints:

Case (i): welded connections subjected to moment acting in a plane normal to the plane of the weld.

(i) Direct shear force due to force 'P'.

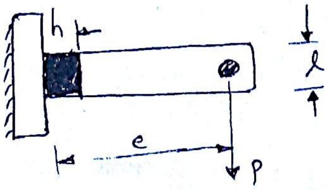
(ii) Bending stress due to Bending moment $(P \times e)$



(i) double Parallel fillet

$$P = 1.414\, h l \tau$$

$$\tau = \frac{P}{1.414 h l}$$



(ii) Bending stress due to Bending moment

$$\frac{M_b}{I} = \frac{\sigma_b}{y}$$

$$\sigma_b = \frac{M_b \times y}{I} = \frac{M_b}{I/y} = \frac{M_b}{Z_w}$$

$$Z_w = \frac{1}{6} t l^2 = \frac{1}{6} 0.707 h l^2 \;\ldots \text{ Single side}$$

$$Z_w = \frac{2 \times 0.707 h l^2}{6} \;\ldots \text{ for both side}$$

$$\sigma_b = \frac{M_b}{Z_w}$$

$$= \frac{P \times e \times 6}{2 \times 0.707 h l^2}$$

$$\sigma_b = \frac{4.24\, Pe}{h l^2}$$

(i) max. normal stress ($\sigma_{t(max)}$)

$$\sigma_{t(max)} = 1/2 \left[\sigma_b + \sqrt{\sigma_b^2 + 4\tau^2}\right]$$

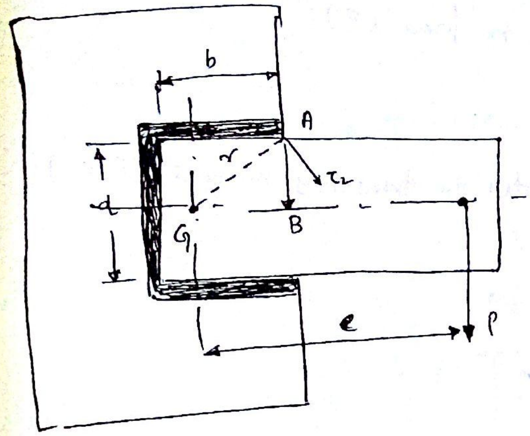
Resultant stress due to direct shear and bending stress is obtained by

$$\tau_{res} = \frac{1}{2} \sqrt{\sigma_b^2 + 4\tau^2}$$

Case (ii): Welded connections subjected to moment in the Plane of the weld.

(a) Direct (or) Primary Stress due to load ($P_1 = P$)

(b) Secondary shear due to turning moment ($P \times e$) of load P which tends to rotate the Joint about 'G'.



(i) direct shear stress

$$A = 0.707h\,(2b+d)$$

$$\tau_1 = \frac{P}{A} = \frac{P}{0.707h(2b+d)}$$

(ii) secondary shear stress

$$\tau_2 = \frac{M_t \times r}{J_w}$$

$$M_t = P \times e$$

$$r = \sqrt{GB^2 + AB^2}$$

J_w = PSGDB, P. No: 11.5

$$\tau_2 = \frac{P \times e \times r}{J_w}$$

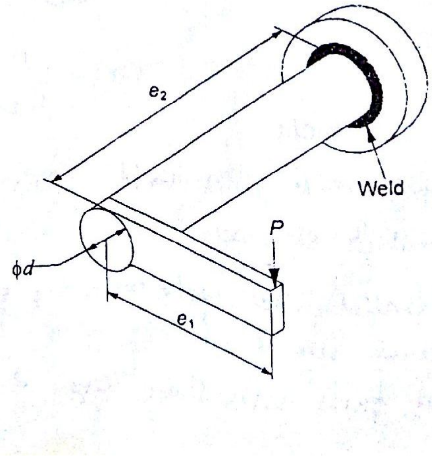
$$\tau_{Res} = \sqrt{\tau_1^2 + \tau_2^2 + 2\tau_1\tau_2\cos\theta}$$

$$\cos\theta = \frac{GB}{GA} = \frac{GB}{r}$$

The Resultant stress should not exceed τ_{max}.

Case (iii):

Welded connections subjected to direct shear, bending and torsional loads:



(i) Direct shear force due to load (P):

$$\tau_1 = P/A$$

(ii) Secondary shear stress due to twisting moment ($P \times e_2$)

$$\tau_2 = \frac{M_t \times r}{J_w}$$

$$\tau_2 = \frac{P \times e_2 \times r}{J_w}$$

Resultant Stress (τ_{res}) = $\sqrt{\tau_1^2 + \tau_2^2}$

(iii) Bending stress

$$\sigma_b = \frac{P \times e}{Z_w}$$

Resultant Stress due to τ and σ_b is

$$\tau_{res} = \frac{1}{2}\sqrt{\sigma_b^2 + 4\tau^2}$$

Note : The resultant stress should not exceed τ_{max}.

Stress Concentration factor:

Stress concentration is present at the weldment because of abrupt changes in cross section.

Type of weld:	Stress Concentration factor
1. Static load	1
2. Reinforced butt weld	1.2
3. Toe of transverse fillet weld or Normal fillet weld	1.5
4. End of parallel fillet weld or longitudinal weld	2.7
5. T- butt joint with sharp corner	2.0