\+ Advantages of welded connection :->

1) As no holes are required for welding the c/s area of member is effective hence more effective in taking load.

2) welded joint provide rigidity and strength

3) Welded structures are comparatively lighter than bolted structure.

4) A welded joint has better finish and appearence

5) Welded joint are economical and less labour and material are required for joint.

6) No noise is produce in the welding process

7) welded structure maintenance & painting are easy.

* Disadvantage

1) welded connection required skill labour.

2) without electricity you can't weld.

3) Internal stresses and warping are produced due to eneven heating and cooling.

4) It is difficult to inspect. air pocket incomplet penetration in welding.

5) Testing of welded joint is difficult

* Welded connections :->

There are two types of welded connectio

1) Butt weld or groove weld.
2) lap weld

1) Butt weld or groove weld.

when the member is connected in a same plane butt weld are used.

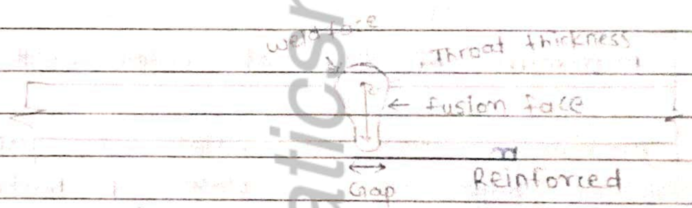
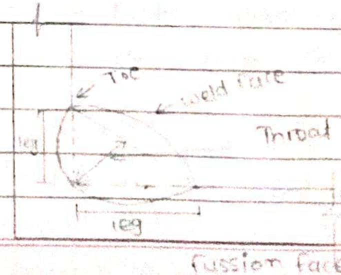


fig Butt weld

2) lap weld

when the member is allowed to lap one over other lap welding is prefered.



lap Joint

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* welded connection :->

1) size of fillet weld :-> (s)

size of normal fillet weld is taken equal to its minimum leg length.

a) minimum size

Thickness of thinner plate	minimum size
1) upto 10 mm	3mm
2) 11 to 20 mm	5 mm
3) 21 to 32 mm	6mm
4) 32 to 50 mm	10 mm

b) maximum of size of fillet weld :->

maximum size of fillet weld applied to a square edge of a plate of thickness above 6 mm should not exceed thickness of the edge minus 1.5.

square edge = $t - 1.5$, where t = thickness of thinner plate

for rounded or rolled steel section. maximum size of fillet weld not exceed $\frac{3}{4} \times t$

rolled or rounded section = $\frac{3}{4} \times t$ where, t = thickness of Rolled section

* Throat thickness (t_t) :->

It is the perpendicular distance from the root of the fillet weld to the line ~~joing~~ joining its toe.

It is taken equal to - K × size of fillet weld

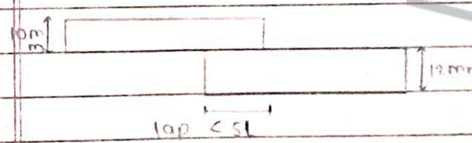
t_t = K × size of fillet weld.

The value of k is depend upon angle of fusion

Angle between fusion face	60°-90°	91-100	101-106	107-113	114-120
K	0.7	0.65	0.6	0.55	0.5

In almost case value of k = 0.7

* overlap :-> The overlap in the lap joint should not be less than five time of thickness of thinner plate.



for. ex :
lap = $5 \times t = 5 \times 10 = 50$

where t = thickness of thinner plate

* Side fillet or side weld :-> In a lap joint made by a side or longitudinal fillet weld the length of each fillet weld should not be

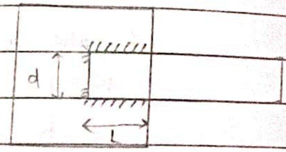
less than perpendicular distance between them

l = not less than d
d = not exceed $16t$
d = width of plate.

* End returns :→

fillet weld terminating at end or side of part or member should preferably be return continuously around the corner for a distance not less than twice the weld side.

End returns = $2 \times S$



S = Size of fillet weld.

* Problems of welding :→

Type-1 : welding on three side

i) size of weld (S) :→

i) minimum size of weld :
as per thickness is consider

ii) maximum size of weld :
Square = $t - 1.5$
Rolled section = $\frac{3}{4} \times t$

where t = thickness of thinner plate.

ii) throat thickness (t_t) :

$t_t = K \times S$ (OR) $t_t = 0.7 \times S$

iii) design stress of weld :

$$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}}$$

γ_{mw} : 1) shop weld = $\gamma_{mw} = 1.25$
2) site weld = $\gamma_{mw} = 1.5$

If not given take $\gamma_{mw} = 1.5$

iv) strength of weld per mm length :

$$P_q = f_{wd} \times 1 \times t_t$$

v) factored load :

1) If Pdw is given take same value.

2) If Pdw is not given and length is given

$$P_{dw} = f_{wd} \times L \times t_t$$

3) If Pdw and length is not given and size of plate is given

$$P_{dw} = \frac{A_g \times f_y}{\gamma_{m0}}$$

where

1) $A_g = b \times t$
2) $f_y = 250\ N/mm^2$
3) $\gamma_{m0} = 1.1$

vi) effective length of weld :→

$$l_e = \frac{P_{dw}}{P_q}$$

vii) End returns :→ End returns = 2×S.

viii) welding on three side :

$$l_e = x + d + x$$
$$l_e = 2x + d$$
$$l_e - d = 2x$$
$$x = \frac{l_e - d}{2}$$

where d = width of plate

3-1-23

Q.1) calculate the lap of one plate having size 120×10 mm. over other plate of size 180×12 mm transmit a pull of equal to full strength of smaller plate. assume fillet weld of 6mm size and welding is operated on three side on the field. use yield stress as fy = 250 mpa. whereas ultimate stress as fu = 410 in steel.

given data :

Plate 1 = 120×10 mm
Plate 2 = 180×12 mm
size of weld (S) = 6mm
f_y = 250 mpa
f_u = 410 mpa.
γ_{mw} = 1.5
welding on three side = ?

1) size of fillet weld (s) = 6mm

2) throat thickness (tt) :

$$t_t = K \times S = 0.7 \times 6$$
$$t_t = 4.2\ mm$$

3) design stress of weld :

$$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.5}$$

$f_{wd} = 157.80\ N/mm^2$

4) strength of weld per mm length :

$P_q = f_{wd} \times 1 \times t_t = 157.80 \times 1 \times 4.2$

$P_q = 662.79\ N/mm$

5) Factor load :→

$$P_{dw} = \frac{A_g \times f_y}{\gamma_{m0}} \quad . \quad \gamma_{m0} = 1.1$$

$$P_{dw} = \frac{120 \times 10 \times 250}{1.1}$$

$P_{dw} = 272.72 \times 10^3\ N$

6) effective length (le) :

$$l_e = \frac{P_{dw}}{P_q} = \frac{272.72 \times 10^3}{662.79}$$

$l_e = 411.48\ mm$

[$l_e \simeq 420\ mm$]

7) End returns $= 2 \times S = 2 \times 6 = 12\ mm$

8) welding on three side

$l_e = x + d + x$

$420 = x + 120 + x$

$420 - 120 = 2x$

$300 = 2x$

$x = \frac{300}{2}$

[$x = 150\ mm$]

Q.2) a 80 x 8 mm plate is to be connected to a 120x8 mm plate in a lap joint .to transmit factored pull of 125 kN. use 6 mm size weld calculate weld on three side.

given data :

Plate 1 = 80x8 mm

Plate 2 = 120x8 mm

$P_{dw} = 125\ kN = 125 \times 10^3\ N$

$S = 6\ mm$

1) size of weld (S) = 6mm

2) throat thickness (t_t) :

$t_t = K \times S = 0.7 \times 6$

$t_t = 4.2$

3) design stress of weld :

$$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.5}$$

$f_{wd} = 157.80$ N/mm²

4) strength of weld per mm length :

$P_q = f_{wd} \times 1 \times tt = 157.80 \times 1 \times 4.2$

$P_q = 662.79$ N/mm

5) factored load :

$P_{dw} = 125 \times 10^3$ N

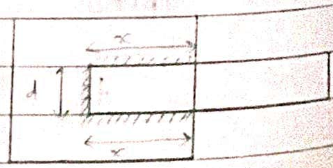
6) effective length (le) :

$$le = \frac{P_{dw}}{P_q} = \frac{125 \times 10^3}{662.79}$$

le = 188.59 mm

[le ≃ 200 mm]

7) welding on three side :



$$x = \frac{le - d}{2} = \frac{200 - 80}{2}$$

x = 60 mm

As · x = 60 mm is less than d = 80 mm

So we cant provide x = 60 mm

Provide x = 100 mm

3) design a suitable fillet weld of size 4 mm. to connect a tie bar 80×8 mm to 10 mm thick gusset plate. Joint has to be design for full strength of the tie bar and welding on all three sides. take fy = 250 mpa, γ_{m0} = 1, fu = 410 mpa. and γ_{mw} = 1.5 draw a neat sketch showing lap length.

given data :

S = 4 mm

Plate size = 80 × 8 mm

thickness = 10 mm

fy = 250 mpa

γ_{m0} = 1.1

fu = 410 mpa

γ_{mw} = 1.5

welding on three side = ?

1) size of weld (s) = 4 mm

2) throat thickness (tt) :

tt = k×s = 0.7×4

tt = 2.8 mm

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3) design stress of weld :

$$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.5}$$

$$f_{wd} = 157.80 \text{ N/mm}^2$$

4) strength of weld per mm length :→

$$P_q = f_{wd} \times 1 \times t_t = 157.80 \times 1 \times 2.8$$

$$P_q = 441.84 \text{ N/mm}$$

5) factored load :

$$P_{dw} = \frac{A_g \times f_y}{\gamma_{m0}} = \frac{80 \times 8 \times 250}{1.1}$$

$$P_{dw} = 145.45 \times 10^3 \text{ N}$$

6) effective length (le)

$$l_e = \frac{P_{dw}}{P_q} = \frac{145.45 \times 10^3}{441.845}$$

$$l_e = 329.49 \text{ mm}$$

[$l_e \simeq 340$ mm]

7) welding on three side.

$$l_e = x + d + x$$

$$340 = 2x + 80$$

$$340 - 80 = 2x$$

$$2x = 260$$

$$x = \frac{260}{2}$$

[$x = 130$ mm]

4) Find safe load transmitted by fillet weld between a flat 60 mm wide over lapping 100 mm over gusset plate. thickness of both plate is 10 mm. where is on all side of overlap. size of weld is 6mm. which is provided at shop.

given data :

Plate 1 = 60x10 mm

Plate 2 = 100x 10 mm

thickness = 10 mm

s = 6mm

welding at shop : $\gamma_{mw} = 1.25$

1) Size of weld (s) = 6mm

2) throat thickness (tt) :

$$t_t = K \times S = 0.7 \times 6$$

$$t_t = 4.2 \text{ mm}$$

3) design stress of weld

$$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.25}$$

$$f_{wd} = 189.37 \ N/mm^2$$

4) strength of weld per mm length

$$P_q = f_{wd} \times 1 \times t_t = 189.37 \times 1 \times 4.2$$

$$P_q = 795.35 \ N/mm$$

5) factor load :

$P_{dw} =$ ~~Ag~~ $f_{wd} \times L \times t_t$ $\qquad L = 60 + 60 = 120$ mm

$$P_{dw} = 189.37 \times 120 \times 4.2$$

$$P_{dw} = 95.44 \times 10^3 \ N$$

6) safe load $= \frac{P_{dw}}{1.5} = \frac{95.44 \times 10^3}{1.5}$

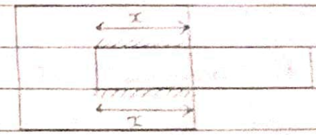
$$= 63.62 \times 10^3 \ N$$

[Safe load = 63.62 KN]

Type - 2 : Find longitudinal weld

- 7 steps are same as type 1

8) welding on longitudinal side :



$$l_e = x + x$$

$$l_e = 2x$$

$$x = \frac{l_e}{2}$$

1) Plate 150x10 mm is connected by 8 mm fillet weld. find lap required to be provided for longitudinal weld only. draw neat sketch showing lap length take fu = 410 mPa

given data :

Plate size = 150x10 mm

S = 8 mm

fu = 410 mpa.

longitudinal weld = ?

1) size of weld (S) = 8mm

2) throat thickness (t_t) :

$$t_t = k \times S = 0.7 \times 8$$

$$t_t = 5.6 \ mm$$

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3) design stress of weld :

$$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.5}$$

$$f_{wd} = 157.80 \ N/mm^2$$

4) Strength of weld per mm length :

$$P_q = f_{wd} \times 1 \times t_t = 157.80 \times 1 \times 5.6$$

$$P_q = 883.73 \ N/mm$$

5) factor load :

$$P_{wd} = \frac{A_g \times f_y}{\gamma_{mo}} = \frac{150 \times 10 \times 250}{1.1}$$

$$P_{wd} = 340.90 \times 10^3 \ N$$

6) effective length :→

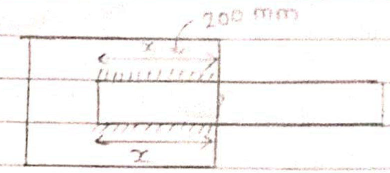
$$l_e = \frac{P_{dw}}{P_q} = \frac{340.90 \times 10^3}{883.73}$$

$$l_e = 385.76 \ mm$$

$$l_e \cong 400 \ mm$$

7) End returns = $2 \times S = 2 \times 8 = 16$ mm

8) welding on longitudinal side :



$$l_e = x + x$$

$$l_e = 2x$$

$$\frac{400}{2} = x$$

[$x = 200$ mm]

2) A 100 mm wide and 12 mm thick tie plate has been connected to a gusset plate by 10 mm fillet weld. the lap of the plate over gusset plate is 120 mm. Fillet weld has been done. on two longitudinal edge and not at end. find out strength fillet weld joint.

given data :

Plate size = 100 x 12 mm

S = 10 mm

length (L) = 120 mm

1) Size of weld (S) = 10 mm

2) throat thickness (t_t) :

$$t_t = K \times S = 0.7 \times 10$$

$$t_t = 7 \ mm$$

3) design stress of weld :

$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.5}$

$f_{wd} = 157.80 \ N/mm^2$

4) strength of weld per mm length :

$P_q = f_{wd} \times 1 \times t_t = 157.80 \times 1 \times 7$

$P_q = 1104.66 \ N/mm$

5) factor load :

$P_{dw} = f_{wd} \times L \times t_t$

$P_{dw} = 157.80 \times (120+120) \times 7$

$P_{dw} = 265.104 \times 10^3 \ N$

6) effective length (le)

$l_e = \frac{P_{dw}}{P_q} = \frac{1104.66}{26} \quad \frac{265.104 \times 10^3}{1104.66}$

$l_e = 239.98$ mm

[$l_e \simeq 240$ mm]

7) End returns $= 2 \times S = 2 \times 10 = 20$ mm

8) welding on longitudinal side :

$l_e = x + x$

$240 = 2x$

$x = \frac{240}{2}$

[$x = 120$ mm]

9) safe load $= \frac{P_{dw}}{1.5} = \frac{265.104 \times 10^3}{1.5}$

safe load $= 176.73 \times 10^3$ N

[safe load = 176.73 kN]

Type- 3 : Welding on three side and C_{xx} is given.

11-06-22 , 5-22

1) design a suitable fillet weld connection for ISA 80×50×8 with its logger leg connected to gusset plate of thickness 8 mm. the angl is subjected to factor load of 275 kN. take $C_{xx} = 27.3$. assume welding is applied to two edges and shop welding. $f_y = 250$ mpa $f_u = 410$.

given data :

ISA = 80×50×8 mm

gusset plate thickness = 8 mm

Pdw = 275 kN
= 275×10^3 N

Cxx = 27.3

G_y = 250 mpa

fu = 410 mpa.

Shop weld γ_{mw} = 1.25.

1) size of weld (s) :

minimum size of weld = 3mm

maximum size of weld (S_{max}) = $\frac{3}{4} \times t = \frac{3}{4} \times 8$

S_{max} = 6 mm

Provide [S = 5 mm]

2) throat thickness (tt) = K×S = 0.7×5
= 3.5 mm

3) design stress of weld :

$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.25}$

f_{wd} = 189.37 N/mm^2

4) strength of weld per mm length :

Pq = fwd × 1 × tt = 189.37 × 1 × 3.5

Pq = 662.79 N/mm

5) factored load :

Pdw = 275×10^3 N.

6) effective length (le) :

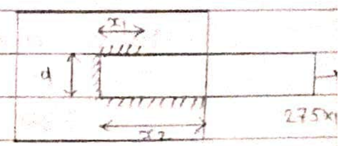
$l_e = \frac{P_{dw}}{P_q} = \frac{275 \times 10^3}{662.79}$

le = 414.91 mm

le ≃ 430 mm

7) End returns = 2×S = 2×5 = 10 mm

8) welding on three side and cxx is given :



$P_q \times x_1 \times d + P_q \times d \times \frac{d}{2} - (P_{dw} \times C_{xx}) = 0$

$662.79 \times 10^3 \times x_1 \times 80 + 662.79 \times 80 \times \frac{80}{2} - (275 \times 10^3 \times 27.3) = 0$

$53.02 \times 10^3 \times x_1 - 5.386 \times 10^6 = 0$

$53.02 \times 10^3 \times x_1 = 5.386 \times 10^6$

$x_1 = \frac{5.386 \times 10^6}{53.02 \times 10^3}$

$x_1 = 101.58$ mm

$[x_1 \cong 110 \text{ mm}]$

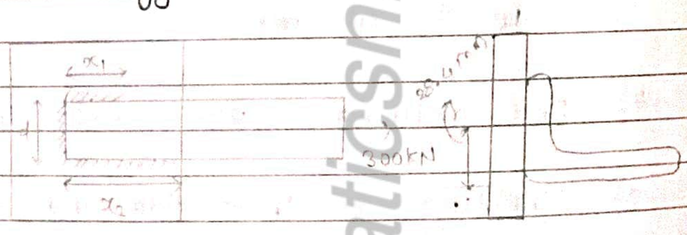
$l_e = x_1 + d + x_2$

$x_2 = l_e - x_1 - d$

$x_2 = 430 - 110 - 80$

$[x_2 = 240 \text{ mm}]$

2) Calculate the length of fillet weld required to connect ISA. 100x100x10. with gusset plat 6mm. weld as shown is figure. the angl is subjected to factored axial force 300kN c_{yx} and = c_{yy} is 28.4 mm



given data :

ISA = 100x100x10 mm

thickness of gusset weld = 6m

P_{dw} = 300kN = 300×10^3 N

$c_{xx} = c_{yy} = 28.4$ mm

$f_u = 410$ N/mm²

$f_y = 250$ N/mm²

1) size of fillet weld (s) :

minimum size of weld $(S_{min}) = 3$mm

maximum size of weld $(S_{max}) = \frac{3}{4} \times t$

$= \frac{3 \times 10}{4}$

$S_{max} = 7.5$ mm

Provide $[S = 6 \text{ mm}]$

2) throat thickness $(t_t) = k \times s = 0.7 \times 6$

$t_t = 4.2$ mm

3) design stress of weld :

$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.5}$

$f_{wd} = 157.80$ N/mm²

4) Strength of weld per mm length :

$P_q = f_{wd} \times 1 \times t_t = 157.80 \times 1 \times 4.2$

$P_q = 662.76$ N/mm

5) factored load $(P_{dw}) = 300 \times 10^3$ N

6) effective length (l_e) =

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$l_e = \frac{P_{dw}}{P_q} = \frac{300\times10^3}{662.76}$

$l_e = 452.65$ mm

$l_e \approx 460$ mm

7) End Returns $= 2\times S = 2\times6 = 12$ mm

8) welding on three side & c_{xx} & c_{yy} is given.

$(P_q \times x_1 \times d) + \left(P_q \times d \times \frac{d}{2}\right) - (P_{dw} \times c_{xx}) = 0$

$(662.76 \times x_1 \times 100) + \left(662.76 \times 100 \times \frac{100}{2}\right) - (300\times10^3 \times 28.4) = 0$

$66276 x_1 - 5.206\times10^6 = 0$

$66276 \times x_1 = 5.206\times10^6$

$x_1 = \frac{5.206\times10^6}{66276}$

[$x_1 = 78.55$ mm]

[$x_1 = 80$ mm]

$l_e = x_1 + d + x_2$

$460 = 80 + 100 + x_2$

$460 = 180 + x_2$

$460 - 180 = x_2$

$280 = x_2$

[$x_2 = 280$ mm]

Q.3] ISA 100x100x10 is welded with gusset plate of 12 mm. to carry factored pull of 300 kN. and its centroid 28 mm from outstanding leg. design fillet weld only on both side of weld angle. assume. fe = 410 & shop weld.

given data:

ISA = 100x100x10 mm

thickness of gusset plate = 12 mm.

$P_{dw} = 300$ kN $= 300\times10^3$ N

$c_{xx} = 28$ mm

$f_u = 410$ N/mm²

$\gamma_{mw} = 1.15$

1) size of weld :

minimum size of weld (S_{min}) = 3mm

maximum size of weld (S_{max}) $= \frac{3}{4}\times t$

$= \frac{3}{4}\times10$

$S_{max} = 7.5$ mm

provide $[s = 6\ mm]$

2) throat thickness $(t_t) = k \times s = 0.7 \times 6$

$t_t = 4.2\ mm$

3) design stress of weld :

$$f_{wd} = \frac{f_u}{\sqrt{3} \times \gamma_{mw}} = \frac{410}{\sqrt{3} \times 1.25}$$

$f_{wd} = 189.37\ N/mm^2$.

4) strength of weld per mm length :

$P_q = f_{wd} \times 1 \times t_t = 189.37 \times 1 \times 4.2$

$P_q = 795.35\ N/mm$

5) factored load :

$P_{dw} = 300 \times 10^3\ N$

6) effective length :

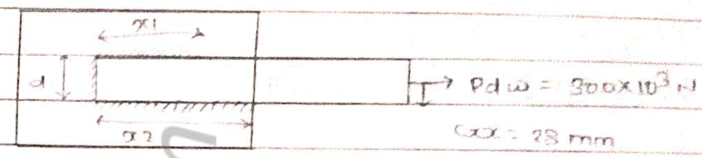
$$l_e = \frac{P_{dw}}{P_q} = \frac{300 \times 10^3}{795.35}$$

$l_e = 377.19\ mm$

$l_e \simeq 390\ mm$

7) End Returns $= s \times 2 = 2 \times 6 = 12\ mm$

8) welding on ~~three~~ side & C_{xx} is given :



$$(P_q \times x_1 \times d) + \left(P_q \times d \times \frac{d}{2}\right) - (P_{dw} \times C_{xx}) = 0$$

$$(795.35 \times x_1 \times 100) + \left(795.35 \times 100 \times \frac{100}{2}\right) - (300 \times 10^3 \times 28) = 0$$

$79535 \times x_1 - 4.42 \times 10^6 = 0$

$79535\ x_1 = 4.42 \times 10^6$

$$x_1 = \frac{4.42 \times 10^6}{79535}$$

$x_1 = 55.57 \simeq 60\ mm$

$l_e = x_1 + d + x_2$

$390 = 60 + 100 + x_2$

$390 - 160 = x_2$

$[x_2 = 230]$