



Stress Concentration Factor for Welded Joints

The reinforcement provided to the weld produces stress concentration at the junction of the weld and the parent metal. When the parts are subjected to fatigue loading, the stress concentration factor as given in the following table should be taken into account.

Stress concentration factor for welded joints.

Type of joint	Stress concentration factor
1. Reinforced butt welds	1.2
2. Toe of transverse fillet welds	1.5
3. End of parallel fillet weld	2.7
4. T-butt joint with sharp corner	2.0

Problem 4

A plate 100 mm wide and 12.5 mm thick is to be welded to another plate by means of parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld so that the maximum stress does not exceed 56 MPa. Consider the joint first under static loading and then under fatigue loading.

Solution

Width = 100 mm ; Thickness = 12.5 mm ; $P = 50 \text{ kN} = 50 \times 10^3 \text{ N}$; $\tau = 56 \text{ MPa} = 56 \text{ N/mm}^2$

Length of weld for static loading

Let l = Length of weld, and

$$s = \text{Size of weld} = \text{Plate thickness} = 12.5 \text{ mm} \dots (\text{Given})$$

We know that the maximum load which the plates can carry for double parallel fillet welds (P),

$$\begin{aligned} 50 \times 10^3 &= 1.414 s \times l \times \tau \\ &= 1.414 \times 12.5 \times l \times 56 = 990 l \end{aligned}$$

$$\therefore l = 50 \times 10^3 / 990 = 50.5 \text{ mm}$$

Adding 12.5 mm for starting and stopping of



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weld run, we have

$$l = 50.5 + 12.5 = 63 \text{ mm} \quad \text{Ans.}$$

Length of weld for fatigue loading

From Table, we find that the stress concentration factor for parallel fillet welding is 2.7.

∴ Permissible shear stress,

$$\tau = 56 / 2.7 = 20.74 \text{ N/mm}^2$$

We know that the maximum load which the plates can carry for double parallel fillet welds (P),

$$50 \times 10^3 = 1.414 s \times l \times \tau = 1.414 \times 12.5 \times l \times 20.74 = 367 l$$

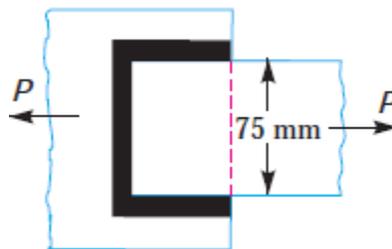
$$\therefore l = 50 \times 10^3 / 367 = 136.2 \text{ mm}$$

Adding 12.5 for starting and stopping of weld run, we have

$$l = 136.2 + 12.5 = 148.7 \text{ mm}$$

Problem 5

A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in Figure. The maximum tensile and shear stresses are 70 MPa and 56 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading.



Solution

Width = 75 mm ; Thickness = 12.5 mm ; $\sigma = 70 \text{ MPa} = 70 \text{ N/mm}^2$; $\tau = 56 \text{ MPa} = 56 \text{ N/mm}^2$.

The effective length of weld (l_1) for the transverse weld may be



obtained by subtracting 12.5 mm from the width of the plate.

$$\therefore l_1 = 75 - 12.5 = 62.5 \text{ mm}$$

Length of each parallel fillet for static loading

Let l_2 = Length of each parallel fillet.

We know that the maximum load which the plate can carry is

$$P = \text{Area} \times \text{Stress} = 75 \times 12.5 \times 70 = 65\,625 \text{ N}$$

Load carried by single transverse weld,

$$P_1 = 0.707 s \times l_1 \times \sigma_t = 0.707 \times 12.5 \times 62.5 \times 70 = 38\,664 \text{ N}$$

and the load carried by double parallel fillet weld,

$$P_2 = 1.414 s \times l_2 \times \tau = 1.414 \times 12.5 \times l_2 \times 56 = 990 l_2 \text{ N}$$

\therefore Load carried by the joint (P),

$$65\,625 = P_1 + P_2 = 38\,664 + 990 l_2 \text{ or } l_2 = 27.2 \text{ mm}$$

Adding 12.5 mm for starting and stopping of weld run, we have

$$l_2 = 27.2 + 12.5 = 39.7 \text{ say } 40 \text{ mm Ans.}$$

Length of each parallel fillet for fatigue loading

From Table, we find that the stress concentration factor for transverse welds is 1.5 and for parallel fillet welds is 2.7.

\therefore Permissible tensile stress,

$$\sigma_t = 70 / 1.5 = 46.7 \text{ N/mm}^2$$

and permissible shear stress,

$$\tau = 56 / 2.7 = 20.74 \text{ N/mm}^2$$

Load carried by single transverse weld,

$$P_1 = 0.707 s \times l_1 \times \sigma_t = 0.707 \times 12.5 \times 62.5 \times 46.7 = 25\,795 \text{ N}$$

and load carried by double parallel fillet weld,



$$P_2 = 1.414 s \times l_2 \times \tau = 1.414 \times 12.5 l_2 \times 20.74 = 366 l_2 \text{ N}$$

∴ Load carried by the joint (P),

$$65\,625 = P_1 + P_2 = 25\,795 + 366 l_2 \text{ or } l_2 = 108.8 \text{ mm}$$

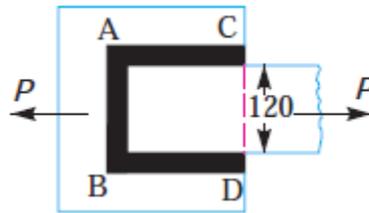
Adding 12.5 mm for starting and stopping of weld run, we have

$$l_2 = 108.8 + 12.5 = 121.3 \text{ mm Ans.}$$

Problem 6

Determine the length of the weld run for a plate of size 120 mm wide and 15 mm thick to be welded to another plate by means of

1. A single transverse weld; and
2. Double parallel fillet welds when the joint is subjected to variable loads.



Solution

Width = 120 mm ; Thickness = 15 mm In Figure, AB represents the single transverse weld and AC and BD represents double parallel fillet welds.

1. Length of the weld run for a single transverse weld

The effective length of the weld run (l_1) for a single transverse weld may be obtained by subtracting 12.5 mm from the width of the plate.

$$\therefore l_1 = 120 - 12.5 = 107.5 \text{ mm Ans.}$$

2. Length of the weld run for a double parallel fillet weld subjected to variable loads

Let l_2 = Length of weld run for each parallel fillet, and

$$s = \text{Size of weld} = \text{Thickness of plate} = 15 \text{ mm}$$



Assuming the tensile stress as 70 MPa or N/mm² and shear stress as 56 MPa or N/mm² for static loading. We know that the maximum load which the plate can carry is

$$P = \text{Area} \times \text{Stress} = 120 \times 15 \times 70 = 126 \times 10^3 \text{ N}$$

From Table, we find that the stress concentration factor for transverse weld is 1.5 and for parallel fillet welds is 2.7.

∴ Permissible tensile stress,

$$\sigma_t = 70 / 1.5 = 46.7 \text{ N/mm}^2$$

and permissible shear stress,

$$\tau = 56 / 2.7 = 20.74 \text{ N/mm}^2$$

∴ Load carried by single transverse weld,

$$P_1 = 0.707 s \times l_1 \times \sigma_t = 0.707 \times 15 \times 107.5 \times 46.7 = 53\,240 \text{ N}$$

and load carried by double parallel fillet weld,

$$P_2 = 1.414 s \times l_2 \times \tau = 1.414 \times 15 \times l_2 \times 20.74 = 440 l_2 \text{ N}$$

∴ Load carried by the joint (P),

$$126 \times 10^3 = P_1 + P_2 = 53\,240 + 440 l_2 \text{ or } l_2 = 165.4 \text{ mm}$$

Adding 12.5 mm for starting and stopping of weld run, we have

$$l_2 = 165.4 + 12.5 = 177.9 \text{ say } 178 \text{ mm } \mathbf{Ans.}$$



Homework الصباحي

A plate 90 mm wide and 15 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld. Determine the length of parallel fillet if the joint is subjected to both static and fatigue loading, taking tensile stress as 70 MPa or N/mm² and shear stress as 56 MPa or N/mm². Stress concentration factor may be taken as 1.5 for transverse fillet and 2.7 for parallel fillet weld.

Homework المسائي

Prove that the normal stress in case of annular fillet weld subject to bending is

$$\frac{5.66 M}{\pi s d^2}$$