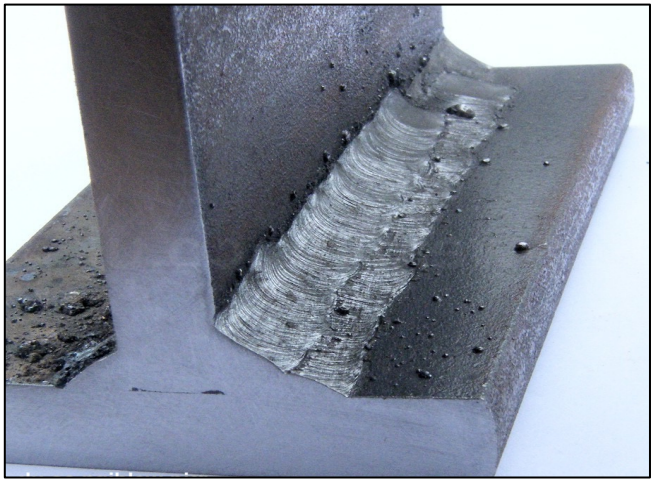
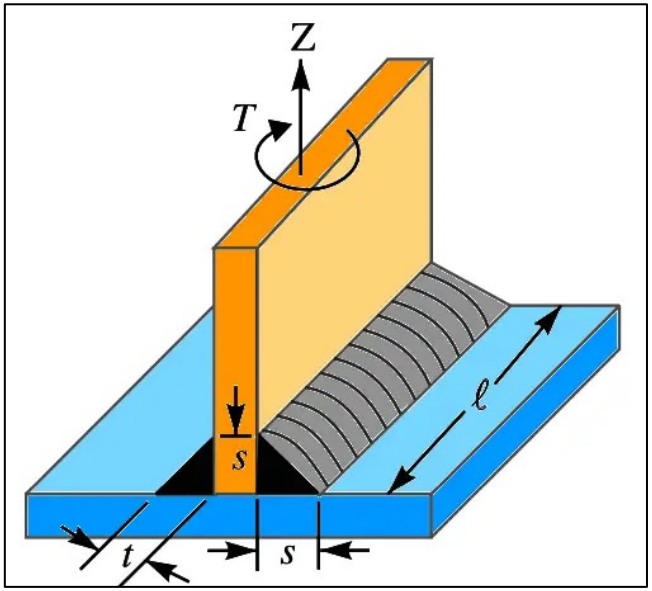
Machine Design

Course No. MEC3110

FILLET WELDED JOINTS

- Fillet welding refers to the process of joining two pieces of metal together when they are perpendicular or at an angle.
- These welds are commonly referred to as tee joints, which are two pieces of metal perpendicular to each other, or lap joints, which are two pieces of metal that overlap and are welded at the edges.
- The weld is triangular in shape and may have a concave, flat or convex surface depending on the welder's technique.
- Welders use fillet welds when connecting flanges to pipes and welding cross sections of infrastructure, and when bolts are not strong enough and will wear off easily

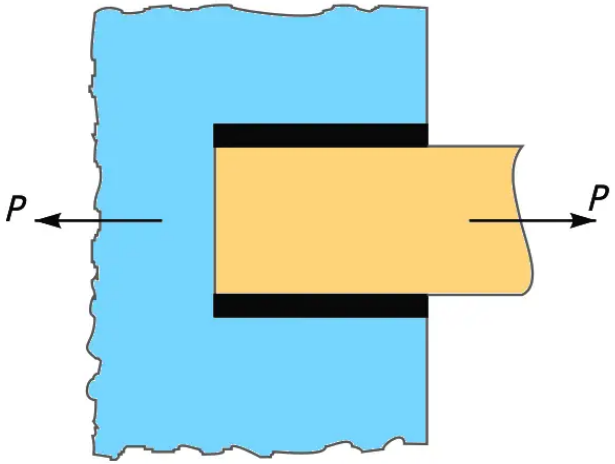




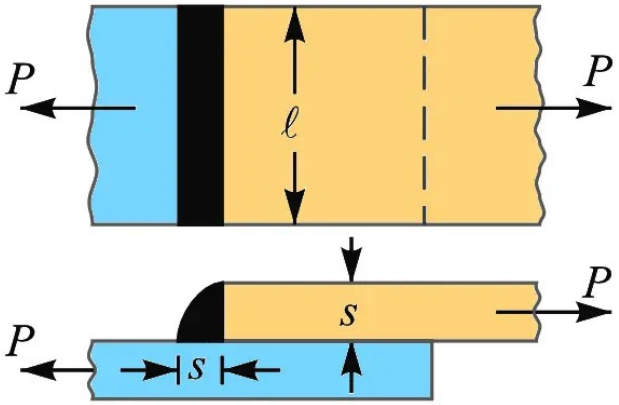
TYPE OF FILLET WELDED JOINTS

There are two main types of fillet weld:

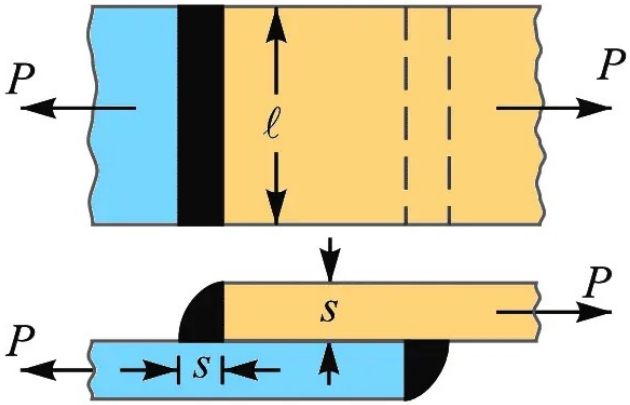
- **Parallel Fillet Weld**
- **Transverse Fillet Weld**
  - Single Transverse Fillet Weld
  - Double Transverse Fillet Weld



Parallel Fillet Weld



Single Transverse Fillet Weld



Double Transverse Fillet Weld

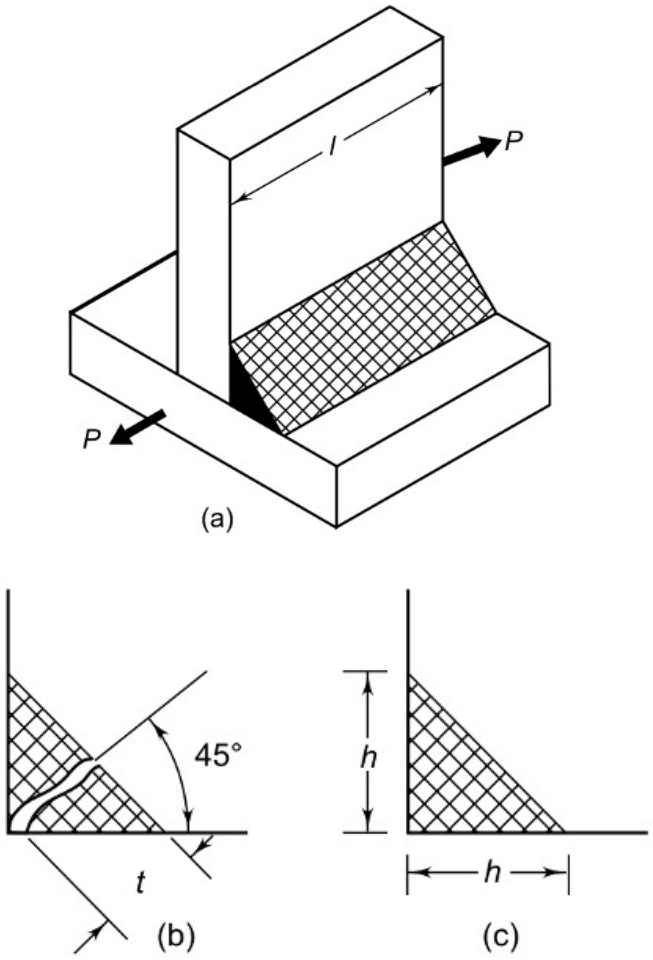
Parallel Fillet Weld

DESIGN OF PARALLEL FILLET WELDS

- A parallel fillet weld subjected to a tensile force P. There are two terms related to the dimensions of the fillet weld, *viz.*, leg h and throat t.
- The size of the weld is specified by the leg length. The cross-section of the fillet weld consists of a right-angled triangle having two equal sides.
- The length of each of the two equal sides is called a *leg*. As a rule, the leg length h is equal to the plate thickness.
- The *throat* is the minimum cross-section of the weld located at 45° to the leg dimension. Therefore,

$$t = h \cos(45°)$$

$$t = 0.707\, h$$



Parallel Fillet Weld in Shear

DESIGN OF PARALLEL FILLET WELDS

- Failure of the fillet weld occurs due to shear along the minimum cross-section at the throat.
- For parallel fillet weld, the inclination of the plane where maximum shear stress is induced, is 45° to the leg dimension.
- The cross-sectional area at the throat is (tl) or ($0.707\ hl$). The shear stress in the fillet weld is given by,

$$\tau = \frac{P}{0.707\ hl} \quad \Rightarrow \quad P = 0.707\ hl\tau$$

where,

P = tensile force on plates (N)
h = leg of the weld (mm)
l = length of the weld (mm)
τ = permissible shear stress for the weld (N/mm^2)

DESIGN OF PARALLEL FILLET WELDS

Usually, there are two welds of equal length on two sides of the vertical plate.

Therefore,

$$P = 2\,(0.707\,hlt)$$

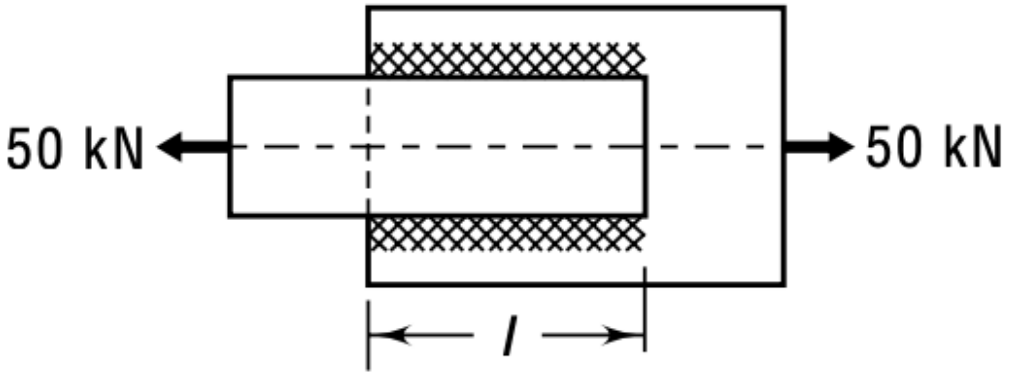
$$\Rightarrow \quad P = 1.414\,hlt$$

- In determining the required length of the weld, 15 mm should be added to the length of each weld calculated by above Eqns. to allow for starting and stopping of the weld run.
- In case of a static load, the permissible shear stress for the fillet welds is taken as 94 N/mm^2 as per the code of American Welding Society (AWS).

DESIGN OF PARALLEL FILLET WELDS

Problem

A steel plate, 100 mm wide and 10 mm thick, is welded to another steel plate by means of double parallel fillet welds as shown in Fig. The plates are subjected to a static tensile force of 50 kN. Determine the required length of the welds if the permissible shear stress in the weld is 94 N/mm².



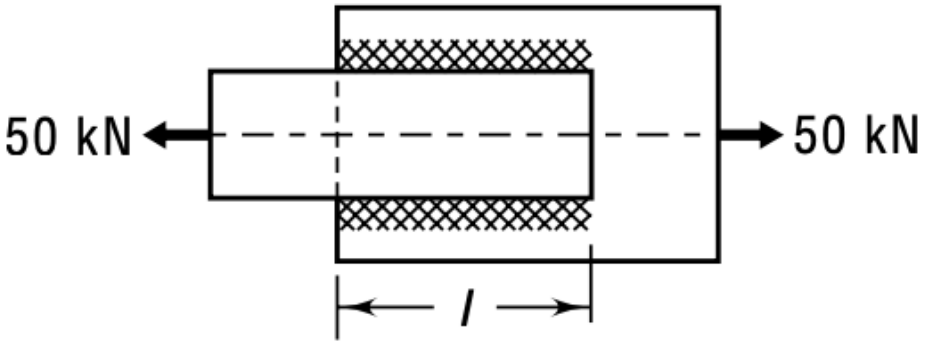
DESIGN OF PARALLEL FILLET WELDS

Problem

A steel plate, 100 mm wide and 10 mm thick, is welded to another steel plate by means of double parallel fillet welds as shown in Fig. The plates are subjected to a static tensile force of 50 kN. Determine the required length of the welds if the permissible shear stress in the weld is 94 N/mm$_2$.

Solution

Given $P = 50$ kN, $\tau = 94$ N/mm^2, $h = 10$ mm



Length of weld

We know that,

$$P = 1.414\, hlt$$

$$\Rightarrow \quad 50 \times 10^3 = 1.414\,(10)\, l\,(94) \qquad \Rightarrow \quad l = 37.62 \text{ mm}$$

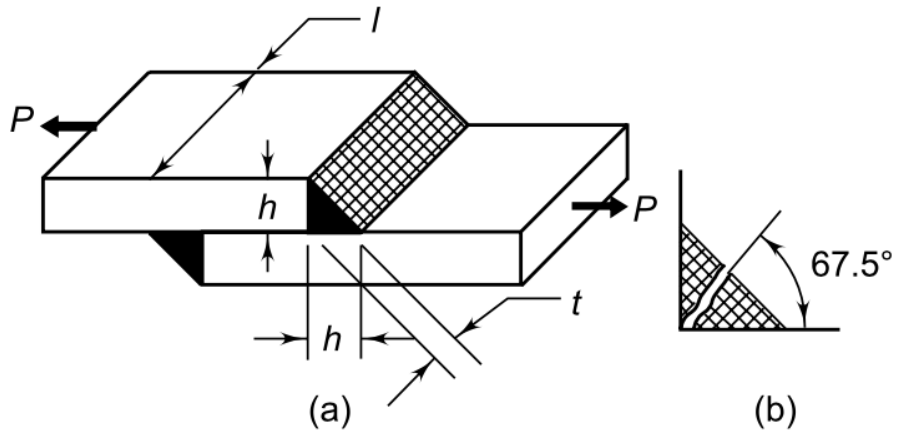
Adding 15 mm of length for starting and stopping of the weld run, the length of the weld is given by,

$$\boldsymbol{l = (37.62 + 15)\text{mm} = 52.62 \text{ or } 55 \text{ mm}}$$

Transverse Fillet Weld

DESIGN OF TRANSVERSE FILLET WELDS

A transverse fillet weld subjected to a tensile force P is shown in Fig. The transverse fillet welds are subjected to tensile stress. The minimum cross- section of the weld is at the throat.



Transverse Fillet Weld in Shear

Therefore, the failure due to tensile stress will occur at the throat section. The cross-sectional area at the throat is (tl). The tensile stress in the transverse fillet weld is given by,

$$\sigma_t = \frac{P}{tl}$$

DESIGN OF TRANSVERSE FILLET WELDS

We know that,

$$t = 0.707\ h$$

$$\Rightarrow \qquad \sigma_t = \frac{P}{0.707\ hl}$$

Rearranging the terms, the strength equation of the transverse fillet weld is written in the following form,

$$P = 0.707\ hl\sigma_t$$

where,

σ_t = permissible tensile stress for the weld (N/mm^2)

Usually, there are two welds of equal length on two sides of the plate as shown in Fig. In such cases,

$$P = 2\ (0.707\ hl\sigma_t)$$

$$\Rightarrow \qquad P = 1.414hl\sigma_t$$

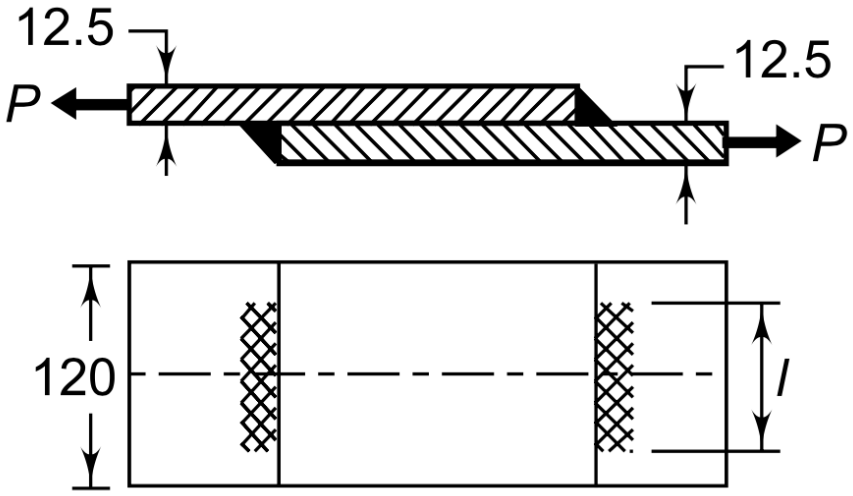
DESIGN OF TRANSVERSE FILLET WELDS

- The nature of stresses in the cross-section of the transverse fillet weld is complex.
- The weld is subjected to normal stress as well as shear stress.
- In addition, the throat is subjected to bending moment, which adds to the complications.
- Theoretically, it can be proved that for transverse fillet weld, the inclination of the plane, where maximum shear stress is induced, is 67.5° to the leg dimension.
- In order to simplify the design of fillet welds, many times shear failure is used as the failure criterion.
- It is assumed that the stress in the transverse fillet weld is shear stress on the throat area for any direction of applied load.

DESIGN OF TRANSVERSE FILLET WELDS

Problem

Two steel plates, 120 mm wide and 12.5 mm thick, are joined together by means of double transverse fillet welds as shown in Fig. The maximum tensile stress for the plates and the welding material should not exceed 110 N/mm^2. Find the required length of the weld, if the strength of weld is equal to the strength of the plates.



DESIGN OF TRANSVERSE FILLET WELDS

Solution

Given

For plates $w = 120$ mm $t = 12.5$ mm

For welds $h = 12.5$ mm $\boldsymbol{\sigma}_t = 110$ N/mm^2

Step 1: Tensile force on plates

The plates are subjected to tensile stress. The maximum tensile force acting on the plates is given by,

$$P = (wt)\boldsymbol{\sigma}_t = (120 \times 12.5)\ (110) = 165\ 000 \text{ N}$$

Step II: Length of the weld

We know that, $P = 1.414\ hl\boldsymbol{\sigma}_t$

$\Rightarrow$ $165\ 000 = 1.414\ (12.5)\ l\ (110)$

$\Rightarrow$ $l = 84.87$ mm

Adding 15 mm of length for starting and stopping of the weld run, the length of the weld is given by,

$$\boldsymbol{l = 84.87 + 15 = 99.87 \text{ or } 100 \text{ mm}}$$