Module 10

Design of Permanent Joints

Lesson 3

Welded Joints: Types and Uses

Instructional Objectives:

At the end of this lesson, the students should be able to know:

- .Different types of welded joints.
- Factors that affect strength of a welded joint.
- Symbols and specifications of welded joints.

1. Welded joints and their advantages:

Welding is a very commonly used permanent joining process. Thanks to great advancement in welding technology, it has secured a prominent place in manufacturing machine components. A welded joint has following advantages:

(i) Compared to other type of joints, the welded joint has higher efficiency. An efficiency > 95 % is easily possible.

(ii) Since the added material is minimum, the joint has lighter weight.

(iii) Welded joints have smooth appearances.

(iv) Due to flexibility in the welding procedure, alteration and addition are possible.

(v) It is less expensive.

(vi) Forming a joint in difficult locations is possible through welding.

The advantages have made welding suitable for joining components in various machines and structures. Some typically welded machine components are listed below.

- Pressure vessels, steel structures.
- Flanges welded to shafts and axles.
- Crank shafts
- Heavy hydraulic turbine shafts
- Large gears, pulleys, flywheels
- Gear housing
- Machine frames and bases
- Housing and mill-stands.

2. Basic types of welded processes:

Welding can be broadly classified in two groups

1) *Liquid state (fusion) welding* where heat is added to the base metals until they melt. Added metal (filler material) may also be supplied. Upon cooling strong joint is formed. Depending upon the method of heat addition this process can be further subdivided, namely
   - Electrical heating: Arc welding
     Resistance welding
     Induction welding
   - Chemical welding: Gas welding
     Thermit welding
   - Laser welding
   - Electron beam welding
2) *Solid state welding*: Here mechanical force is applied until materials deform to plastic state. Bonds are then formed through molecular interaction. Solid state welding may be of various kinds, namely,
   - Cold welding
   - Diffusion welding
   - Hot forging

Descriptions of the individual welding processes are to be found in any standard textbook on welding.

3. Strength of welded joints:

Adequate care must be taken to enhance strength of the welded joint. It is seen that strength of a welded joint gets affected mainly by the following factors.

(i) *Crack initiation*: it is possible that cracks form while cooling a melted metal.

(ii) *Residual stresses*: due to inhomogeneous heating of the base metals, residual stresses may exist upon cooling.

(iii) *Metallurgical transformation*: in heat affected zone (HAZ) metallurgical properties may change leading to weakening of the joint.

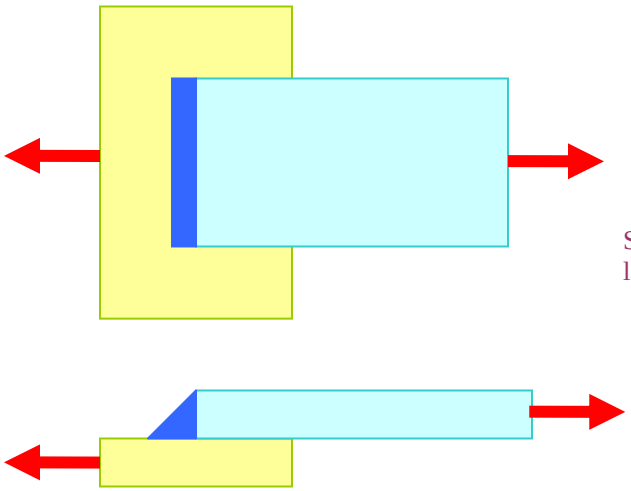
(iv) *Defects*: of various kinds like incomplete penetration, porosity, slag inclusion which affect the strength of a welded joint.

(v) *Stress concentration*: abrupt change in the geometry after welding may introduce stress concentration in the structure.

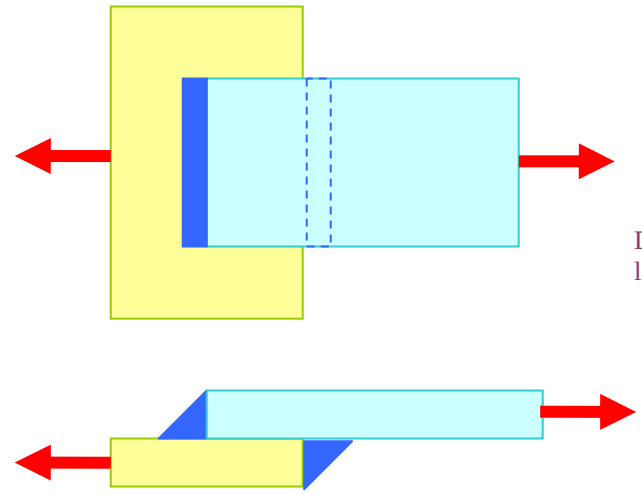
3. Types of welded joints:

Welded joints are primarily of two kinds

a) *Lap or fillet joint*: obtained by overlapping the plates and welding their edges. The fillet joints may be single transverse fillet, double transverse fillet or parallel fillet joints (see figure 10.3.1).



Single transverse lap joint



Double transverse lap joint

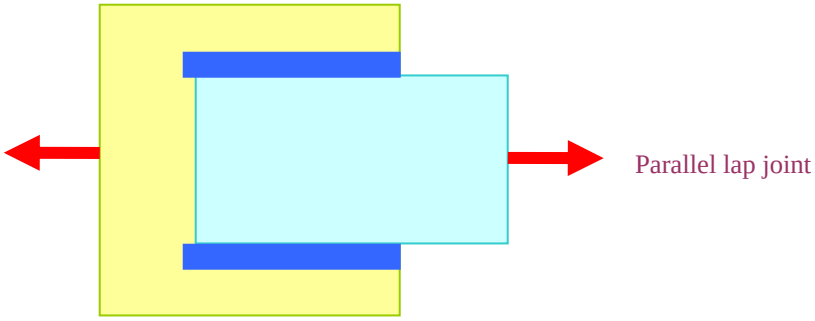


Figure 10.3.1: Different types of lap joints

b) *Butt joints*: formed by placing the plates edge to edge and welding them. Grooves are sometimes cut (for thick plates) on the edges before welding. According to the shape of the grooves, the butt joints may be of different types, e.g.,

- Square butt joint
- Single V-butt joint, double V-butt joint
- Single U-butt joint, double U-butt joint
- Single J-butt joint, double J-butt joint
- Single bevel-butt joint, double bevel butt joint

These are schematically shown in figure 10.3.2.

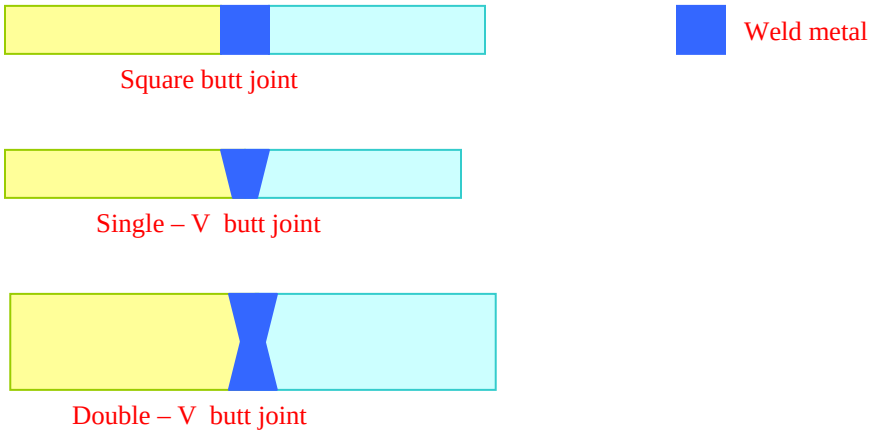


Figure 10.3.2: Different types of butt joints

There are other types of welded joints, for example,

- Corner joint (see figure 10.3.3a)
- Edge or seal joint (see figure 10.3.3b)
- T-joint (see figure 10.3.3c)

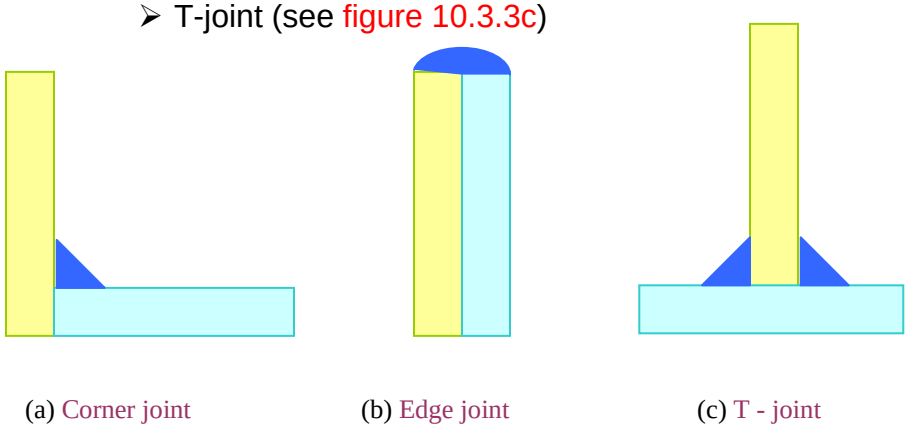


Figure 10.3.3: Other types of welded joints

Each type of joint has its own symbol. The basic weld symbols are shown in Table-10.3.1.

Table10.3.1: Basic weld types and their symbols

Sl. No.	**Type of weld**	**Symbol**
1.	Fillet joint	
2.	Square butt joint	
3	Single V- butt joint	
4	Double V- butt joint	
5	Single U – butt joint	
6	Single bevel butt joint	

After welding is done the surface is properly finished. The contour of the welded joint may be flush, concave or convex and the surface finish may be grinding finish, machining finish or chipping finish. The symbols of the contour and the surface finish are shown in Table-10.3.2.

Table 10.3.2: Supplementary Weld Symbols

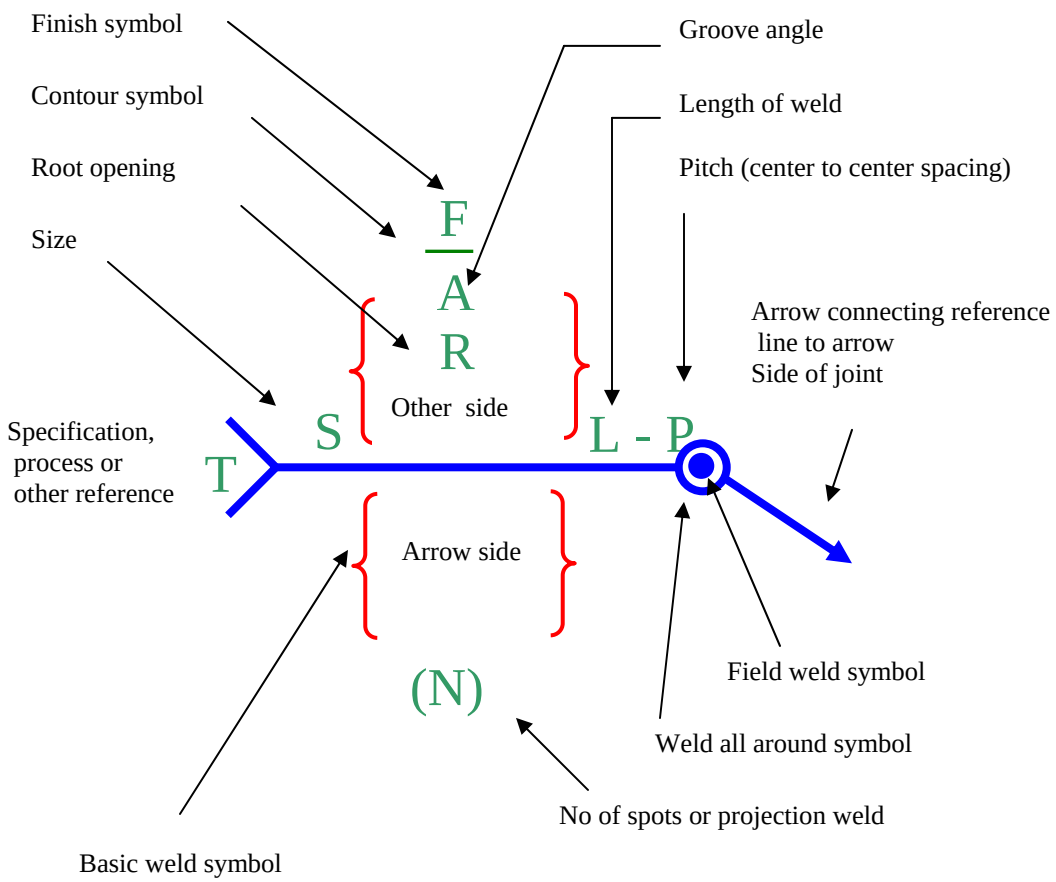
Sl No.	Particulars	Weld Symbol
1	Flush contour	
2	Convex contour	
3	Concave contour	
4	Grinding finish	G
5	Machining finish	M
6	Chipping finish	C

4. Welding symbol:

A welding symbol has following basic elements:

1. Reference line
2. Arrow
3. Basic weld symbols (like fillet, butt joints etc.)
4. Dimensions
5. Supplementary symbols
6. Finish symbols
7. Tail
8. Specification processes.

These welding symbols are placed in standard locations (see figure below)



Example: If the desired weld is a fillet weld of size 10 mm to be done on each side of Tee joint with convex contour, the weld symbol will be as following