Manufacturing / Manufacturing Process/Fundamentals of Welding

Problem Set

No problem set

Examples

No Example

Notes

video

Fundamentals of Welding

The term *joining* is generally used for welding, brazing, soldering, and adhesive bonding, which form a permanent joint between the parts – a joint that cannot easily be separated.

The term *assembly* usually refers to mechanical methods of fastening parts together. Some of these methods allow for easy disassembly, while others do not.

Welding is a materials joining process in which two or more parts are coalesced at their contacting surfaces by a suitable application of heat and/or pressure. Many welding processes are accomplished by heat alone, with no pressure applied; others by a combination of heat and pressure; and still others by pressure alone, with no external heat supplied. In some welding processes a *filler* material is added to facilitate coalescence. The assemblage of parts that are joined by welding is called a *weldment*. Welding is most commonly associated with metal parts, but the process is also used for joining plastics. Our discussion of welding is will focus on metals.

Advantages and Disadvantages of welding

Advantages:

- Welding provides a permanent joint. The welded parts become a single entity.
- The welded joint can be stronger than the parent materials it a filler metal is used that has strength properties superior to those of the parents, and if proper welding techniques are used.
- Welding is usually the most economical way to join components in terms of material usage and fabrication costs. Alternative mechanical methods of assembly require more complex shape alterations (e.g., drilling of holes) and addition of fasteners (e.g., rivets or bolts). The resulting mechanical assembly is usually heavier than a corresponding weldment.
- Welding is not restricted to the factory environment. It can be accomplished "in the field."

Although welding has the advantages indicated above, it also has certain limitations and drawbacks (or potential drawbacks):

Disadvantages:

- Most welding operations are performed manually and are expensive in terms of labor cost. Many welding operations are considered "skilled trades," and the labor to perform these operations may be scarce.
- Most welding processes are inherently dangerous because they involve the use of high energy.
- Since welding accomplishes a permanent bond between the components, it does not allow for convenient disassembly. If the product must occasionally be disassembled (e.g., for repair or maintenance), then welding should not be used as the assembly method.
- The welded joint can suffer from certain quality defects that are difficult to detect. The defects can reduce the strength of the joint.

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OVERVIEW OF WELDING TECHNOLOGY

Welding involves localized coalescence or joining together of two metallic parts at their faying surfaces. The faying surfaces are the part surfaces in contact or close proximity that are to be joined. Welding is usually performed on parts made of the same metal, but some welding operations can be used to join dissimilar metals.

Types of welding processes

Welding is divided into two major groups: (1) Fusion welding and (2) solid-state welding.

Fusion Welding

Fusion welding processes use heat to melt the base metals. In many fusion welding operations, a filler metal is added to the molten pool to facilitate the process and provide bulk and strength to the welded joint. A fusion-welding operation in which no filler metal is added is referred to as an autogenous weld. The fusion category includes the most widely used welding processes, which can be organized into the following general groups.

Arc welding (AW). Arc welding refers to a group of welding processes in which heating of the metals is accomplished by an electric are, as shown in Figure 7.1. Some arc welding operations also apply pressure during the process and most utilize a filler metal.

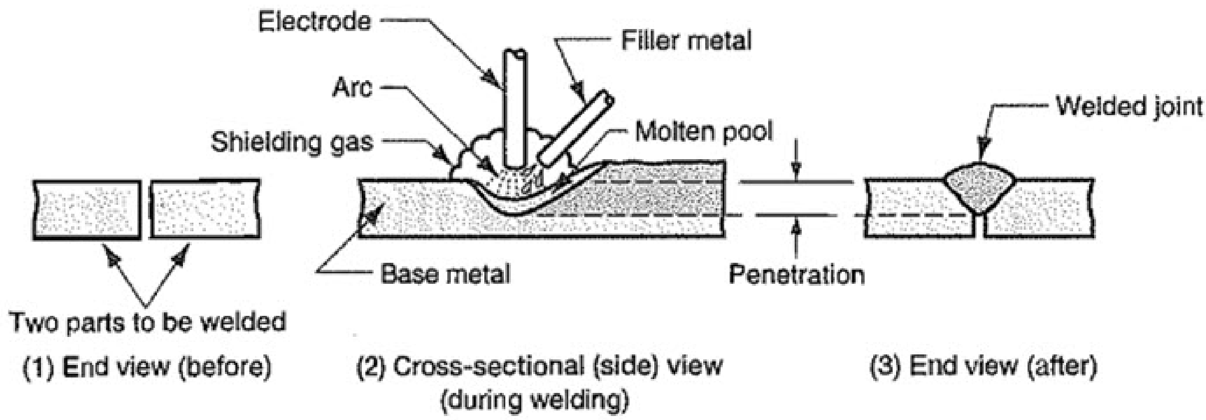

Figure 7.1 Basics of arc welding: (1) before the weld; (2) during the weld (the base metal is melted and filler metal is added to the molten pool); and (3) the completed weldment. There are many variations of the arc-welding process.

Resistance welding (RW). Resistance welding achieves coalescence using heat from electrical resistance to the flow of a current passing between the faying surfaces of two parts held together under pressure.

Oxyfuel gas welding (OFW). These joining processes use an oxyfuel gas, such as a mixture of oxygen and acetylene, to produce a hot flame for melting the base metal and filler metal, if one is used.

Other fusion-welding processes. Other welding processes that produce fusion of the metals joined include electron beam welding and laser beam welding.

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Solid-state welding

Solid state welding refers to joining processes in which coalescence results form application of pressure alone or a combination of heat and pressure. If heat is used, the temperature in the process is below the melting point of the metals being welded. No filler metal is utilized.

Welding as a commercial operation

Applications of welding:

The principal applications of welding are

(1) Construction, such as buildings and bridges.

(2) Piping, pressure vessels, boilers, and storage tanks.

(3) Shipbuilding

(4) Aircraft and aerospace and

(5) Automotive and railroad

Welding is performed in a variety of locations and in a variety of industries. Owing to its versatility as an assembly technique for commercial products, many welding operations are performed in factories. However, several of the traditional processes, such as arc welding and oxyfuel gas welding, use equipment that can be readily moved, so these operations are not limited to the factory. They can be performed at construction sites, in shipyards, at customers' plants, and in automotive repair shops.

Most welding operations are labor intensive. For example, arc welding is usually performed by a skilled worker, called a *welder*, who manually controls the path or placement of the weld to join individual parts into a larger unit.

Safety Issue:

Welding is inherently dangerous to human workers. Strict safety precautions must be practiced by those who perform these operations. The high temperatures of the molten metals in welding are an obvious danger. Most of the processes use high energy to cause melting of the part surfaces to be joined. In many welding processes, electrical power is the source of thermal energy, so there is the hazard of electrical shock to the worker.

Certain welding processes have their own particular perils. In arc welding, for example, ultraviolet radiation is emitted that is injurious to human vision. A special helmet that includes a dark viewing window must be worn by the welder. This window filters out the dangerous radiation but is so dark that it renders the welder virtually blind, except when the arc is struck. Sparks, spatters of molten metal, smoke, and fumes add to the risks associated with welding operations. Ventilation facilities must be used to exhaust the dangerous fumes generated by some of the fluxes and molten metals used in welding. If the operation is performed in an enclosed are, special ventilation suits or hood are required.

Automation in Welding

Because of the hazards of manual welding, and in efforts to increase productivity and improve product quality, various forms of mechanization and automation have been developed. The categories include machine welding, automatic welding, and robotic welding.

Machine welding can be defined as mechanized welding with equipment that performs the operation under the continuous supervision of an operator. The human worker must continually observe and interact with the equipment to control the operation.

If the equipment is capable of performing the operation without adjustment of the controls by a human operator, it is referred to as *automatic welding*. A human worker is usually present to oversee the process and detect variation from normal conditions.

In *robotic welding*, an industrial robot or programmable manipulator is used to automatically control the movement of the welding head relative to the work.

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THE WELD JOINT

Welding produces a solid connection between two pieces, called a weld joint. A weld joint is the junction of the edges or surfaces of parts that have been joined by welding. This section covers two classifications related to weld joints: (1) types of joints and (2) the types of welds used to join the pieces that form the joints.

Types of joints

There are five basic types of joints for bringing two parts together for joining. The five joint types are not limited to welding; they apply to other joining and fastening techniques as well. With reference to Figure 7.2, the five joint types can be defined as follows:

(a) Butt joint. In this joint type, the parts lie in the same plane and are joined at their edges.

(b) Corner joint. The parts in a corner joint form a right angle and are joined at the corner of the angle.

(c) Lap joint. This joint type consists of two overlapping parts.

(d) Tee joint. In the tee joint, one part is perpendicular to the other in the approximate shape of the letter "T".

(e) Edge joint. The parts in an edge joint are parallel with at least one of their edges in common, and the joint is made at the common edges(s).

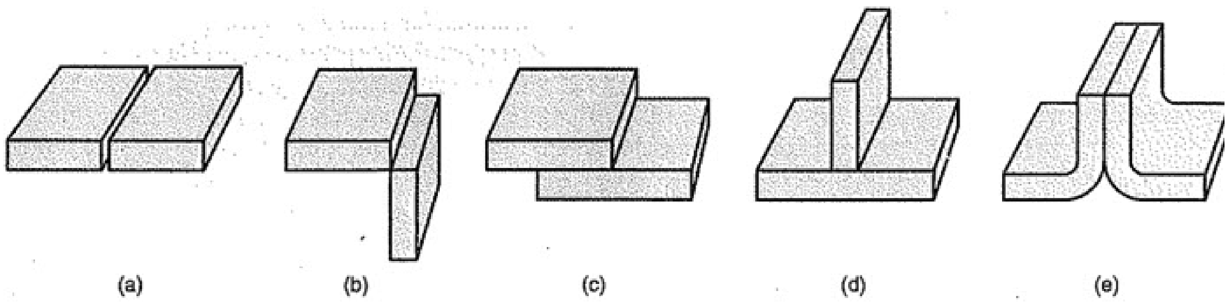

Figure 7.2 Five basic types of joints: (a) butt, (b) corner, (c) lap, (d) tee, and (e) edge.

Types of welds

Each of the preceding joints can be made by welding. It is appropriate to distinguish between the joint type and the way in which it is welded – the weld type. Differences among weld types are in geometry (joint type) and welding process.

A fillet weld is used to fill in the edges of plates created by corner, lap, and tee joints, as in Figure 7.3. Filler metal is used to provide a cross section approximately the shape of a right triangle. It is the most common weld type in arc and oxyfuel welding because it requires minimum edge preparation – the basic square edges of the parts are used. Fillet welds can be single or double (i.e., welded on one side or both) and can be continuous or intermittent (i.e., welded along the entire length of the joint or with unwelded spaces along the length).

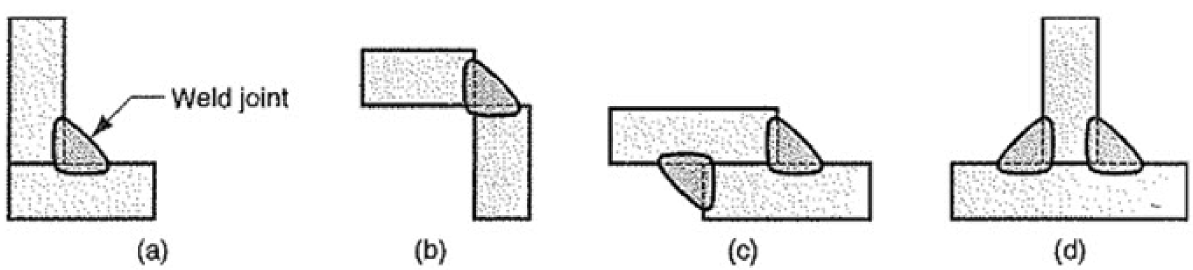

Figure 7.3 Various forms of fillet welds: (a) inside single fillet corner joint; (b) outside single fillet corner joint; (c) double fillet lap joint; and (d) double fillet tee joint. Dashed lines show the original part edges.

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Groove welds usually require that the edges of the parts be shaped into a groove to facilitate weld penetration. The groove shapes include square, bevel, V, U, and J, in single or double sides, as shown in Figure 7.4. Filler metal is used to fill in the joint, usually by arc or oxyfuel welding. Preparation of the part edges beyond the basic square edge, although requiring additional processing is often done to increase the strength of the welded joint or where thicker parts are to be welded. Although most closely associated with a butt joint, groove welds are used on all joint types except lap.

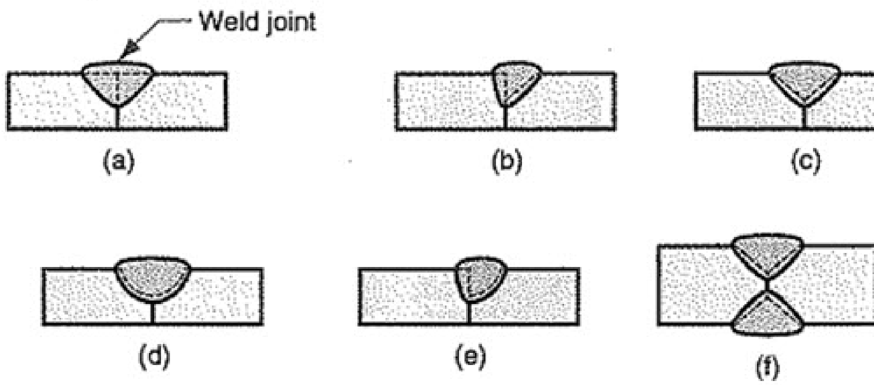

Figure 7.4 Some typical groove welds: (a) square groove weld, one side; (b) single bevel groove weld; (c) single V-groove weld; (d) single U-groove weld; (e) single J-groove weld; (f) double V-groove weld for thicker sections. Dashed lines show the original part edges.

Plug welds and slot welds are used for attaching flat plates, as shown in Figure 7.5, using one or more holes or slots in the top part and then filling with filler metal to fuse the two parts together.

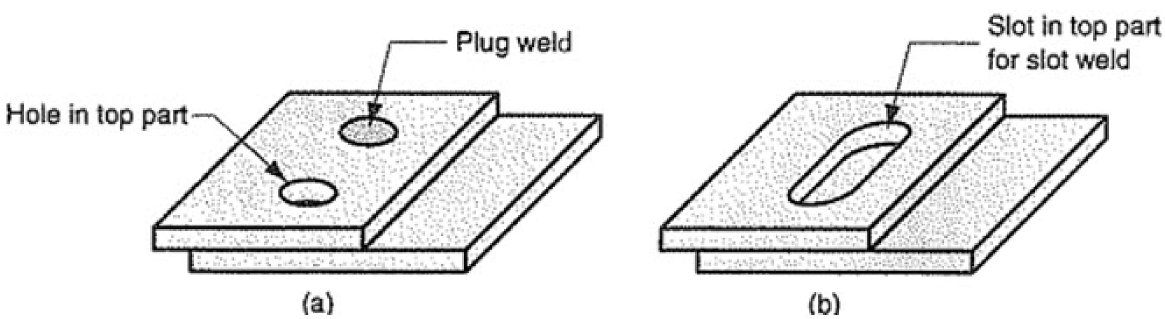

Figure 7.5 (a) Plug weld, and (b) slot weld.

Spot welds and seam welds, used for lap joints, are diagrammed in Figure 7.6. A spot weld is a small fused section between the surfaces of two sheets or plates. Multiple spot welds are typically required to join the parts. It is most closely associated with resistance welding. A *seam weld* is similar to a spot weld except it consists of a more or less continuously fused section between the two sheets or plates.

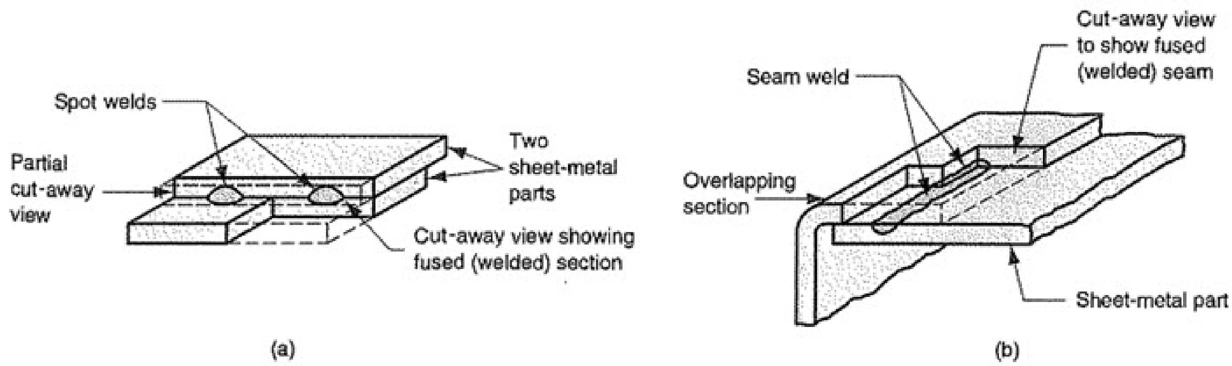

Figure 7.6 (a) Spot weld, and (b) seam weld.

Flange welds and surfacing welds are shown in Figure 7.7. A *flange weld* is made on the edges of two (or more) parts, usually sheet metal or thin plate, at least one of the parts being flanged as in Figure 7.7(a). A *surfacing weld* is not used to join parts, but rather to deposit filler metal onto the surface of a base part in one or more weld beads. The weld beads can be made in a series of overlapping parallel passes, thereby covering large areas of the base part. The purpose is to increase the thickness of the plate or to provide a protective coating on the surface.

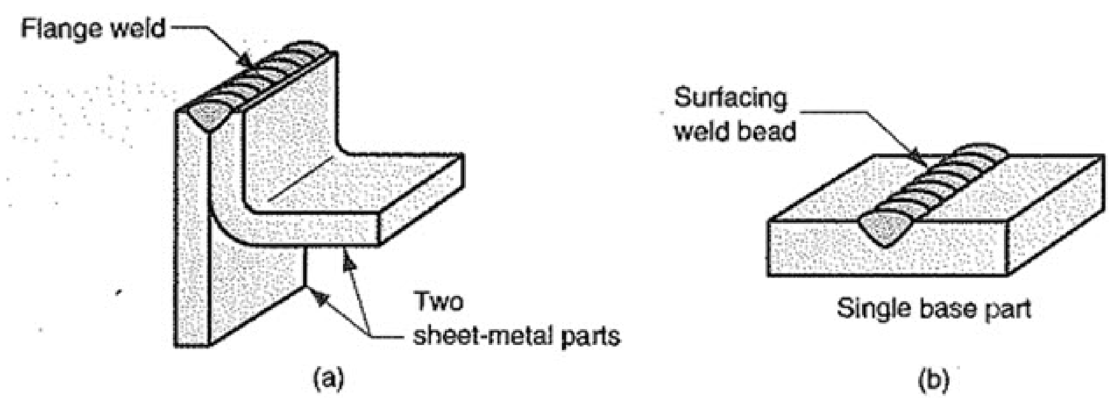

Figure 7.7 (a) Flange weld, and (b) surfacing weld.

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