FROM THE FOUNDATION

Welding Lightweight Steel Framing Members

This article from the June 1988 Foundation Updates has been updated to reflect current developments in the field of welding lightweight steel framing. Updates is published by the Foundation of the Wall and Ceiling Industry.

By Kathy B. Sedgwick, Executive Director

One of the most common construction applications of welding is panelization and prefabrication with lightweight steel framing, that is, steel ranging from 12 to 22 gage. When steel studs and joists are prefabricated into curtain wall assemblies and load bearing exterior wall systems, the components are frequently welded together for strength and rigidity.

Several types of welding are used in lightweight steel framing applications. The most popular is Shielded Metal Arc Welding, commonly called stick welding.

The popularity of Shielded Metal Arc Welding (hereinafter referred to as SMAW) is due to: (1) its versatility; (2) portability of equipment; and (3) the joint strength and quality of the resulting weld.

SMAW is a versatile method which can effectively weld metals as light as 20 gage. It can be used both in the shop or at the job site. Because the power supply leads can be extended for relatively long distances, SMAW can be performed at some distance from the power source.

In addition, SMAW is adaptable to multi-position welding in difficult locations. SMAW can weld joints in any position that can be reached with an electrode (even overhead and vertical joints). Using bent electrodes, a welder can create joints in blind areas normally inaccessible for most other welding processes.

Specially designed assembly fixtures (jigs) are used to hold components at a convenient working level and assure accurate dimensioning. These fixtures in combination with other assembly-line techniques make SMAW a fast and efficient method for accurate shop fabrication.

Since SMAW electrode materials are available to match the properties of most ferrous base metals, the welding rode and the framing member can be a metallurgical match, resulting in stronger welds.

The Shielded Metal Arc Welding (SMAW) Process

In SMAW, an electric welding machine produces an electrical current which is conducted through a cable to an electrode. The electrode is the welding alloy or "stick," which conducts electricity. When the electrode is brought close to the base metal, an arc is produced. This arc is the electrical current jumping across the gap between the electrode and the base metal.

The electrical current meets considerable resistance at the gap between the electrode tip and the base metal. This build up of resistance results in an arc of high temperature, ranging between 10,000 and 12,000° F.

This heat melts the base metal and causes it to form a molten pool. The tip of the electrode also begins to melt, forming droplets, which mix or fuse with the growing molten pool. As the welder moves the electrode along the base metal, the electrical current causes the melting pool to flow away from the electrode, creating a weld bead on the base metal. Eventually the bead cools and solidifies into a homogeneous alloy of the base metals and the welding electrode.

REQUIRED EQUIPMENT

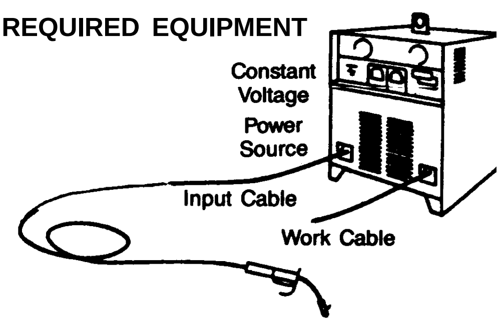

Figure 1. Both the electrode and the base metal are connected to different sides of the power supply.

Theory of Electrical Current

An understanding of the basic theory of electrical current is necessary to fully comprehend the welding process. Electrical current is the rate of flow of electric charges. There are two types: Alternating Current and Direct Current.

Direct Current (DC) flows constantly in one direction, from negative to positive, or from positive to negative. This is referred to as polarity. Alternating Current (AC) travels in one direction for a period of time and then reverses its direction in the circuit for an equal period of time. This entire cycle may be repeated many times per second. The number of cycles occurring per second is measured in units called Hertz (Hz). For example, at 60 Hz (60 cycles per second) the current travels in one direction for 1/120th of a second, and then reverses its direction.

Voltage is the pressure that supports the electric arc across the gap between the electrode and the work surface.

Power is the rate of transforming, transferring, or consuming energy. In welding, power is rate of transferring electrical energy from the power source to the base metal.

Current is measured in amperes, voltage in volts, and power in watts or in kilowatts (1,000 watts).

Power is computed as the product of current and voltage.

Current X Voltage = Power

Therefore, the power of a 300 ampere, 30 volt arc would be computed as follows:

300 amp. X 30 V = 9000 watts
9000 watts = 9 kilowatts

The arc has a power rating of 9000 watts or 9 kilowatts.

Equipment

A welding machine (also called a buzz box or hot box) provides the correct voltage needed to maintain the arc. As amperage (flow or current) increases, the faster the electrode is consumed. Generally, higher settings are required for welding heavier gage steel members.

Historically, stick welding of lightweight galvanized steel framing has been accomplished with transformer/rectifier welding units requiring either single or 3-phase, 230-volt, 50 ampere, D.C. electrical service. These welding units can typically furnish a current output range of 30 to 250 amperes at 30 arc volts, with positive or negative polarity. The welding of 12 to 20 gage galvanized steel framing is normally accomplished within the range of 30 to 75 amps or current.

While most early welding machines used DC, some manufacturers have developed AC equipment which offers several advantages over DC. AC equipment usually costs less because it does not require a rectifier to convert alternating to direct current. And, AC equipment can be used at some distance from the power source without the resistance buildup and overheating of cables common with DC equipment.

The primary advantage attributed to DC welders is a uniform, continuous flow of current to help maintain a smooth, stable welding arc.

More recently, manufacturers have introduced small, portable, automatic wire feed units which utilize coils of flux-core wire electrode with welding machines in field applications; presently, these wire feed units are recommended with DC power sources. The advantage of automatic wire feed units is that the entire electrode is consumed, and there is less interruption to the welder since the "stick" (electrode) does not have to be replaced frequently as it is consumed in the welding process.

Electrodes

Electrodes are made of various kinds of metal wire, and their selection is dependent on the composition of the metal to be welded.

The American Welding Society (AWS) has simplified the electrode selection process by establishing a classification system. Numerical codes identify electrodes made by different manufacturers which have the same general welding characteristics.

With DC welding units, the electrode selected will determine if the welding unit is set for positive or negative polarity.

The electrodes used in SMAW range in size from 1/16 to 5/16 in. diameter, and from 9 to 18 inches long. As an electrode is consumed, the welder replaces the electrode, strikes a new arc, and continues the welding process.

Electrodes are also available in coils of flux-core wire ranging in weight from 14 lbs, used in automatic portable wire feeder units, to coils weighing several hundred pounds for stationary, mounted wire feed units used in the shop.

Electrodes are coated with a material called a flux, which dissolves during welding. The dissolving flux becomes either a neutral or reducing gas (such as carbon dioxide or carbon monoxide) which surrounds the arc.

The electrode's flux melts more slowly than the core wire so that the flux projects slightly beyond the tip of the electrode. This extension of flux concentrates and directs the arc stream, and it protects the melting tip and the molten puddle from the oxygen and nitrogen in the surrounding air. In addition, the chemicals in the flux keep the arc stable, control metal fluidity, and prevent porosity and the formation of hard spots in the molten puddle.

As the weld progresses down the surface of the base metal, a coating called slag forms over the completed weld bead. Although the slag must be wire brushed away later, its formation serves several useful purposes; it aids in fusion, floats impurities to the surface of the weld beads, and insulates the welded point against the cooling (annealing) effects of the atmosphere.

Types of Welds

The types of welds typically used for joining light gage steel framing components to each other are lap joints, fillet welds, and groove welds.

Lap Joints. Probably the joint most frequently used in welding is the lap joint (Figure 2), a joint between two overlapping components. This joint doubles the thickness of the metal.

Fillet Welds. Fillet welds are used to fill in the corners created by the edges of two steel framing members positioned at right angles to each other.

Figure 3 shows a lap joint with a fillet weld. The cross section of the weld is essentially triangular.

Groove Welds. Panelization with lightweight steel framing employs a variety of groove welds, including flare bevel and flare vee groove welds.

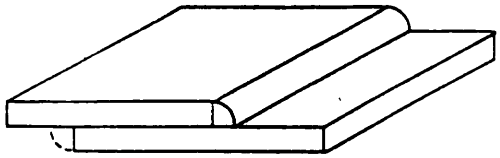

Figure 2. Lap joint.

Figure 3. Lap joint with fillet weld.

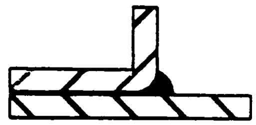

Figure 4. Flare bevel groove weld.

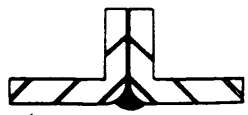

Figure 5. Flare vee-groove weld.

Perhaps the most prevalent weld is the *flare bevel groove weld* (Figure 4). It is similar to a simple fillet weld, except the ends of the framing members are beveled.

The *flare vee-groove weld* (Figure 5) joins the beveled ends of two studs. It is most often used to create a butt joint.

(For more information on selection of welds, see AISI Section 4.2.1.)

Gas Metal Arc Welding (GMAW)

Gas Metal Arc Welding (GMAW) is an arc welding process in which a stream of chemically inert gas — such as Argon or CO_2 — is fed through the welding gun. The gas (or mixture of gases) creates a shield which effectively controls the atmosphere. In this way the gas shield produces much the same results as the flux in SMAW. The gas

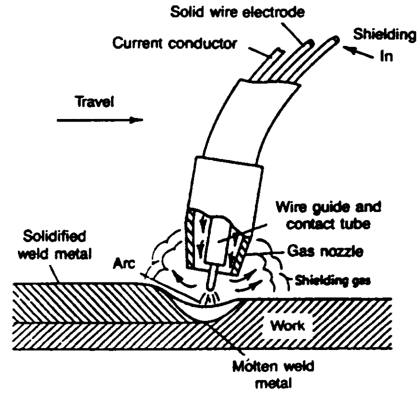

Figure 6. Shielding gas protects the molten metal from the atmosphere.

shield protects the electrode, the weld pool, the arc and adjacent areas of the framing member from atmospheric contamination.

Because the gases used to shield the electrode are chemically inert, the GMAW process is often called metal inert-gas welding (MIG). GMAW is also referred to as Tungsten Inert Gas Welding (TIG) when using a tungsten metal electrode.

GMAW processes are controlled through the use of three basic pieces of equipment: (1) the gun; (2) the wire feed unit; and (3) the power source.

The gun guides the electrode and conducts the electrical current and shielding gas to the weld. In this way it provides two important elements: (1) the energy necessary to create and maintain the arc and melt the electrode and (2) protection from the ambient atmosphere.

The wire feed unit and power sources are normally coupled to make self-regulation of the arc length automatic. This regulation is possible due to a constant voltage power source (flat volt-ampere curve) and a constant speed wire feed unit.

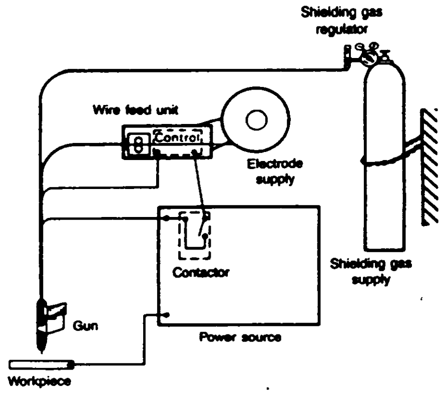

Figure 7. Basic GMAW equipment.

Automatic maintenance of the arc length and current level means that essentially the only manual controls required by the welder for semiautomatic operation are gun positioning, current level, guidance, and travel speed.

GMAW-S. Short circuiting mode of metal transfer, called GMAW-S, is a lower heat energy variation of the process. In this method, the electrode is put in contact with the molten puddle on the work, and the arc is established intermittently. The relationship between the arc and the short circuiting is controlled by the power source characteristics.

Heat input is low, and so weld bead penetration is very shallow, allowing for welding out-of-position and on thin gauge sections. ◘