Smaller, Longer Fillet Welds Reduce Welding Costs

By Duane K. Miller, P.E.

This is the second in a series of articles focusing on welding and the practicing engineer

The strength of a fillet weld is the product of weld metal strength, weld throat, weld length, and any applicable allowable factor. For a given strength of weld metal and allowable factor, the strength of a weld is proportional to the weld throat and length. As the weld length is increased, the weld throat may be proportionally decreased if the loading remains the same.

Consider the two welds shown in **Figure 1**. The ½" (12mm) leg-sized fillet weld is 6" (150mm) long. If the weld is made using E70 (E48) weld metal (70 ksi minimum tensile strength - 480 MPa) with the AWS Dl.1 allowable of 30%, the strength of this weld would be:

F = (cos 45°) (w) (E) (30%) (L)
F = (0.707) (0.50) (70) (0.3) (6)
F = 44 kips (195 KN)

The second weld is a ¼" (6mm) leg size fillet that is 12" (300mm) long. Using the same filler metal and allowable, the preceding calculation results in the same total weld strength. From a design viewpoint, either would be acceptable. There are important differences, however. On a per-length basis, the ½" (12mm) fillet weld requires four times the amount of weld metal as the ¼" (6mm) weld. This is readily seen in **Figure 2**. Although the smaller fillet weld is twice as long, it still requires only half as much weld metal as the larger weld. This would require half as much electrode and, more importantly, half as much welding time.

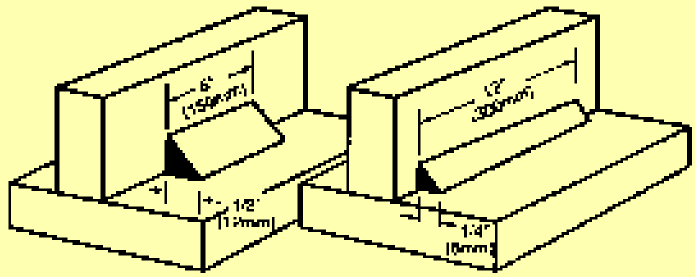

FIGURE 1

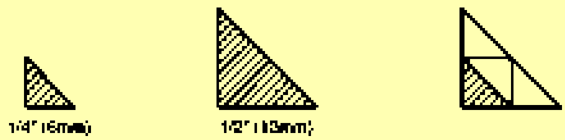

FIGURE 2

If the welds are to be made in the horizontal position as shown in **Figure 1**, the smaller weld can be easily made in a single pass. The larger example requires at least three passes, and probably six, in order to build the weld up to the required size. Between passes, slag will have to be removed, further increasing fabrication costs.

The principle of "smaller size - longer lengths" always holds true. However, the engineer must remember that applying extremely small welds to thicker plates may result in metallurgical problems. The prescribed minimum weld sizes in various codes should not be violated when this principle is applied. For example, for static loading conditions it would be more desirable to use an intermittent minimum sized ¼" (6mm) fillet weld than a continuous ⅛" fillet weld when the plates being joined are ¾" (19mm) thick or greater. For dynamic loading, a continuous ¼" weld would be preferred, since the fatigue behavior would be superior.

While fillet welds have been emphasized here, the same principles apply to partial-joint-penetration (PJP) groove welds.

Case Study

An engineer was asked to design a weld capable of resisting a load of 37 kips. AWS Dl.1 allowable applied, and E70 weld metal was to be used. A 5/16" (8mm) fillet weld 8" (200mm) in length was selected. A ¼" (6mm) fillet weld 10" (250mm) in length would have had the same capacity. The larger weld required 56% more weld metal for the same length, but was 20% shorter than the longer weld. The net result was that the larger fillet weld required 25% more weld metal than the smaller weld. If the two welds were made with a welding procedure that employed the same deposition rate, the larger and shorter weld would require 25% more welding time than the smaller and longer fillet.

Actual data from two production welds provide a dramatic illustration of the savings. The two welds were both made with ⅛" (3.2mm) E7018 electrodes at 130 amperes, with the findings shown in **Table 1**.

At a labor and overhead rate of $25 per hour and an electrode cost of $0.80 per pound, the cost was $4.63 for the 5/16" (8mm) fillet weld and $3.60 for the ¼" (6 mm) fillet weld, resulting in a savings of $0.97 per weld, or 27%. For 10,000 such welds, this concept saved approximately $9,700.

Table 1: Data From Two Production Welds

Weld size	5/16 in. (8mm)	¼ in. (6mm)
Travel speed	2.5"/min (64mm/min)	4"/min (100mm/min)
Arc time per joint	3.2 min.	2.5 min.
Weld time at 30% operating factor	10.7 min.	8.3 min.
Electrode required per length	0.33 lb/ft (0.49 kg/m)	0.22 lb/ft (0.33 kg/m)
Electrode required per joint	0.22 lb (0.33 kg)	0.18 lb (0.27 kg)

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