Consider The Cost Of Joint Preparation When Specifying Weld Type

By Duane K. Miller, P.E.

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

When the required throat size for a specific weld has been determined, the type of weld must be selected. The type of joint (tee, butt, corner, lap, or edge), the ratio of required throat to plate thickness, and the relative access to both sides of the joint will influence the decision. To reduce costs, a good general principle is to select the weld type that will utilize the smallest amount of weld metal per length. However, certain types of welds require more joint preparation, which can increase fabrication costs.

This article will consider two welds that are designated "full strength"—in each case, the connection is as strong as the base material the weld joins. Both welds must be made from one side, since access to the opposite side is limited. **Figure 1** illustrates the two options: a simple, external fillet weld; and a complete joint penetration (CJP) groove weld with a ¼" (6mm) root opening, and a 45° bevel. Both welds exhibit equivalent strength since the throat dimension is the same. In the case of the fillet weld, it would be important to ensure that rotation about the root is limited.

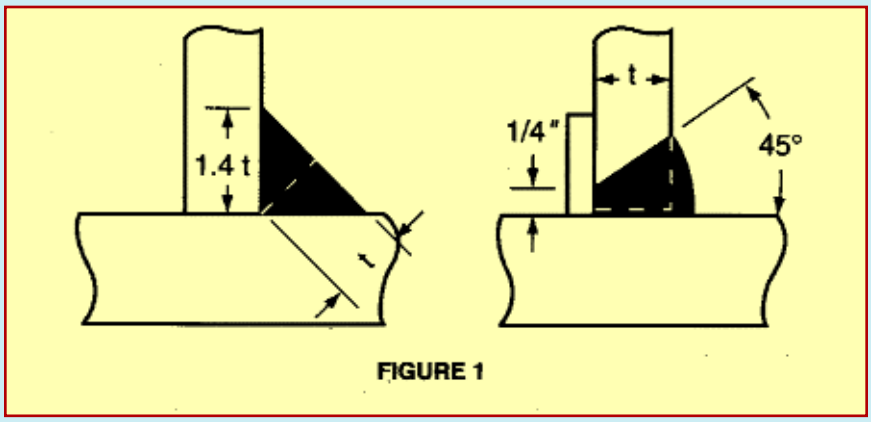


FIGURE 1

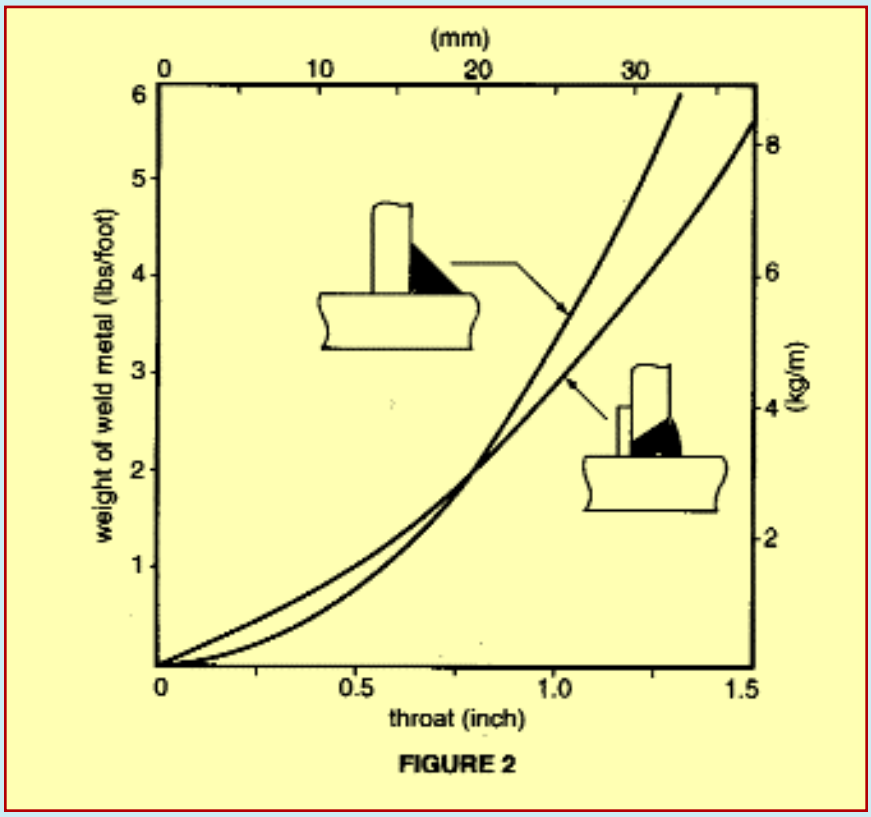
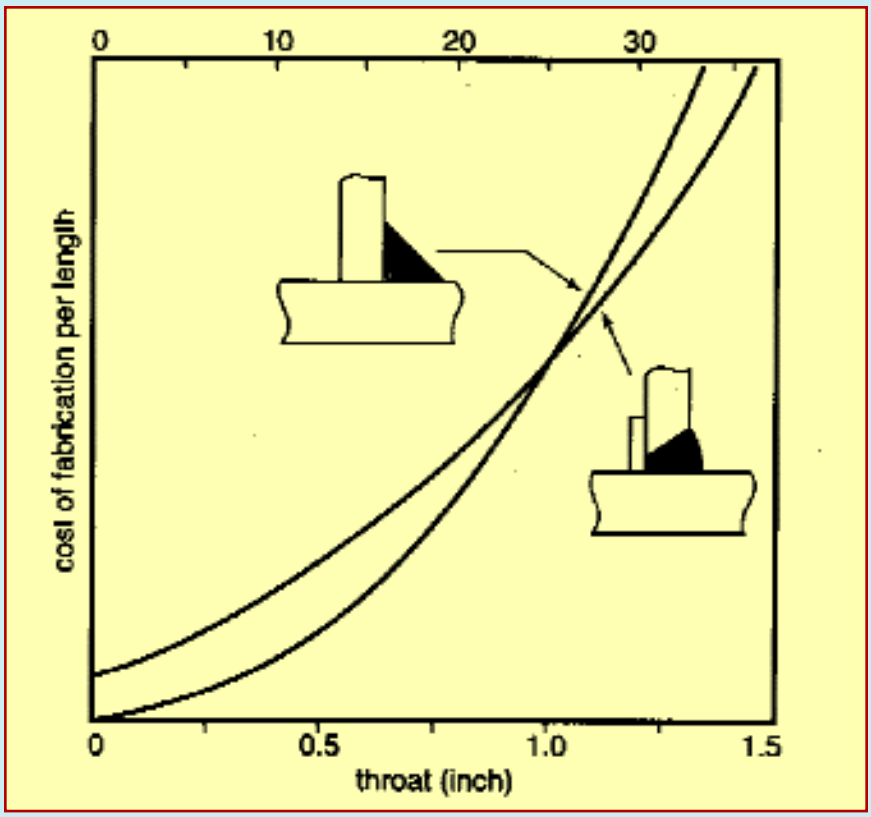


FIGURE 2

Figure 2 plots the difference in weld weight per length. For welds with throat dimensions of 0.75" (19mm) or less, the fillet weld requires less metal. Notice that this equates to a leg size of 0.75 x 1.4 or 1.06" (27mm), a rather substantial fillet weld. Beyond a throat of 0.75" (19mm), the CJP requires less metal.

A code-quality, one-sided CJP groove weld requires some type of backing, usually fitting an auxiliary piece of steel behind the joint and tack welding it in place. For most CJP groove welds, a bevel is applied to the part or parts to ensure access to the root, and yet limit the overall joint volume. The beveling process is expensive and quickly erodes the savings in weld metal shown for the larger weld sizes. By contrast, a fillet weld on a tee joint involves a square-cut edge that can be obtained by sawing, shearing, thermal cutting, or may even be the as-received edge of the piece.

Fitting of the assemblies is also easier for the fillet welded connection: the parts are brought together and placed in close contact. With the CJP connection,



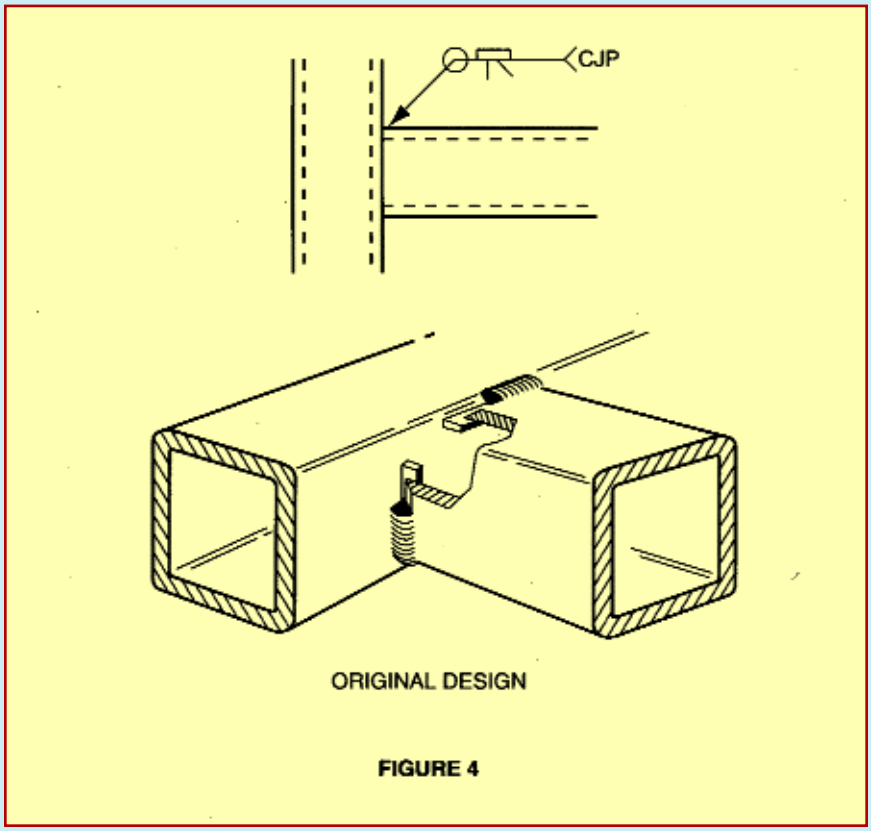


FIGURE 4

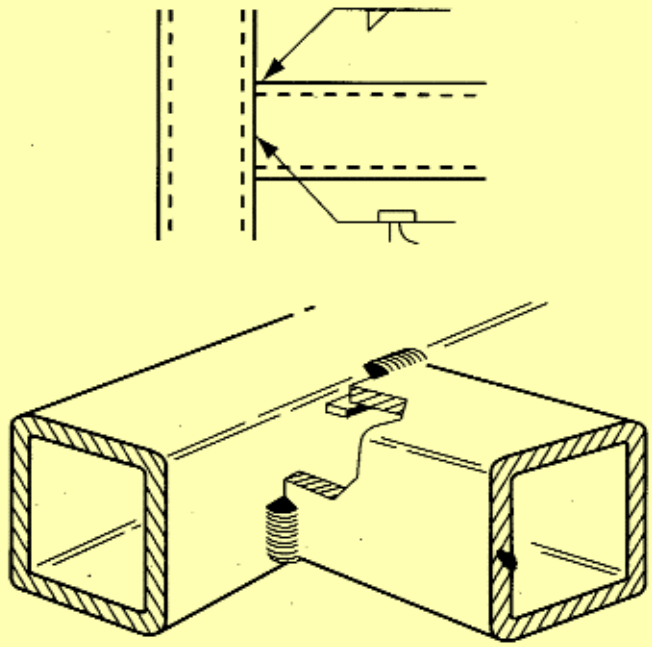
spacing must be maintained to ensure the proper root opening.

Figure 3 is a plot of the total fabrication costs versus throat size for the two options. A plot of the cost of welding labor and materials would be nearly identical to **Figure 2**. The extra cost of the CJP detail, including beveling, backing, fixturing and alignment, moves the cost curve upwards. This has the effect of shifting the break-even point to the right, further increasing the relative economics of the fillet weld option.

For welded designs to be both safe and cost effective, the cost of joint preparation must be considered when the weld type is specified. The engineer who chooses to specify "CJP" essentially eliminates the (often less costly) fillet weld alternative the fabricator may wish to employ.

Case Study

The tubular space frame for the roof structure of a new convention center utilized "matched" square (or boxed) hollow structural sections where the outside dimensions of the shapes were all 8" (200mm). The minimum wall thickness was 3/16" (5mm) and increased all the way to solid sections in some areas. The majority of the HSS had wall thicknesses of ¼" (6mm) to ½" (13mm). Where the sections intersected at a 90 degrees, two sides formed tee joints and the other two made a butt-like joint (see **Figure 4**). The original design shown in **Figure 4** called for CJP welds all around; however, the fabricator felt that using fillet welds for the tee joints would lower the cost, since they would not require beveling and the installation of backing. While fillet welds could not be used on the butt-like joints, a flare bevel groove weld could be substituted, as shown in **Figure 5**. Using the radius of the tubing corners to increase access to the root, a CJP weld could be obtained without beveling. Backing would still be required. (Cost comparison estimates are shown above.)



ALTERNATE DESIGN

FIGURE 5

At a labor and overhead rate of $37.50 per hour, the savings came to $34.00 per tube. Since 850 tubes were involved, costs were reduced by more than $25,000.

Upon seeing the potential savings, the fabricator sought and gained the engineer's approval for the alternate weld type. Since the original design would not have permitted the use of the alternative approach, good communications between the fabricator and the engineer was the real key to this cost effective solution.

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Cost Comparison

Operation	Initital Design	Alt. Design
Saw, tack	same amount of time	
Bevel	(4 sides, 2 ends) 40 minutes	0 minutes
Install backing	(4 sides, 2 ends) 15 minutes	(2 sides, 2 ends) 10 minutes
Fixture in jig	same amount of time	
Weld	(4 bevel groove welds, 2 ends) 165 minutes	(2 fillets, 2 ends) 75 minutes (2 flare groove welds, 2 ends) 80 minutes
Totals	**220 minutes**	**165 minutes**
Savings	**55 minutes per tube, or 0.9 hour per tube**	