Use Double Sided Groove Welds (But Think About It First)

By Duane K. Miller, P.E.

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

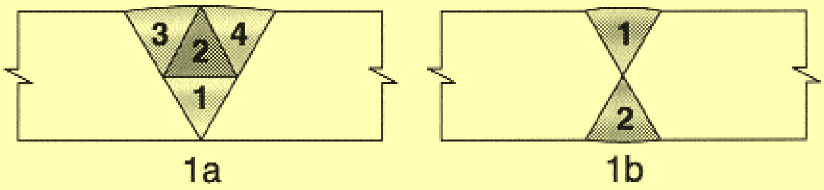


Figure 1

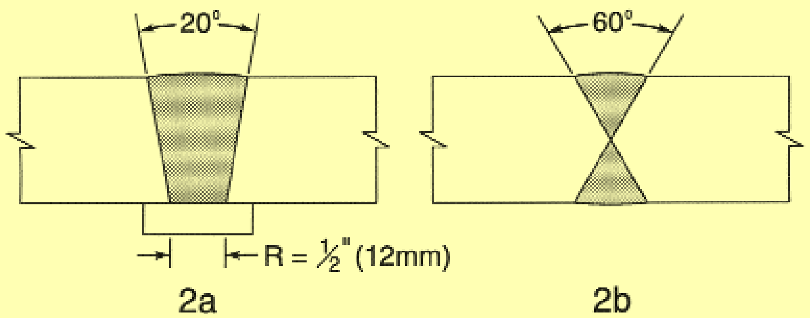


Figure 2

One of the oldest and most often repeated principles of welding design is to "use double sided groove welds where possible." Typically applied to butt configurations, double sided groove welds like the one illustrated in Figure 1b abound, with the double sided V-groove detail offering a 50% decrease in weld volume (and an implied 50% decrease in welding costs). Along with the decreased quantity of weld metal comes a corresponding decrease in residual stress and longitudinal shrinkage. Balancing the quantity of weld metal about the centerline of the plate can reduce angular distortion. If it is assumed that the probability of weld defects is proportional to the volume of weld metal deposited, reduced volume groove weld details should also result in higher quality weld deposits.

Less residual stress, less distortion, higher quality and lower fabrication costs, all achievable with the use of double sided groove welds? It sounds too good to be true. Unfortunately, this is often the case. In order to achieve all of the preceding benefits, the following must be taken into consideration.

Joint Preparation Cost

One bevel cut on one-half of the V-groove joint can be made by a single oxy-fuel cutting torch. The two bevel cuts necessary for the equivalent member on the double sided joint may be made with either two passes of the same single torch, or by one pass of a two-torch system. The labor cost associated with making two passes will be approximately twice that of the two-torch approach, which could justify an investment in mechanized equipment. However, no matter how the double V groove is made, note that the fuel cost will be twice that of a single V-Groove detail.

Root Openings & Included Angles

The theoretical joint details shown in **Figure 1** are atypical. The open root configuration of either detail is usually avoided due to problems with burn-through. For work done under the Dl.1 Structural Welding Code - Steel, neither of these details would be prequalified. For the single V-groove weld, steel backing would be employed. Steel backed joints utilize root openings to ensure fusion to the backing. In contrast, large root openings would be inappropriate for a double sided groove weld where a tightly fit detail is preferred. The included angle of the single V-groove with the increased opening can be decreased as is shown in **Figure 2a**. To prohibit melt-through on the double sided joint, a root face dimension is typically specified. In order to ensure proper root pass cross sectional profiles (width-to-depth ratio), a sufficiently large included angle is required. In **Figure 2b**, a typical double sided V-groove joint is illustrated. Both examples shown in **Figure 2** are prequalified, but neither the root openings nor the included angles are the same.

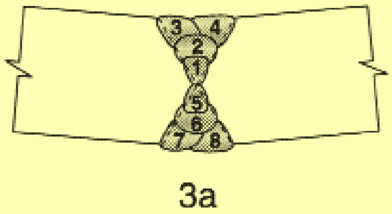
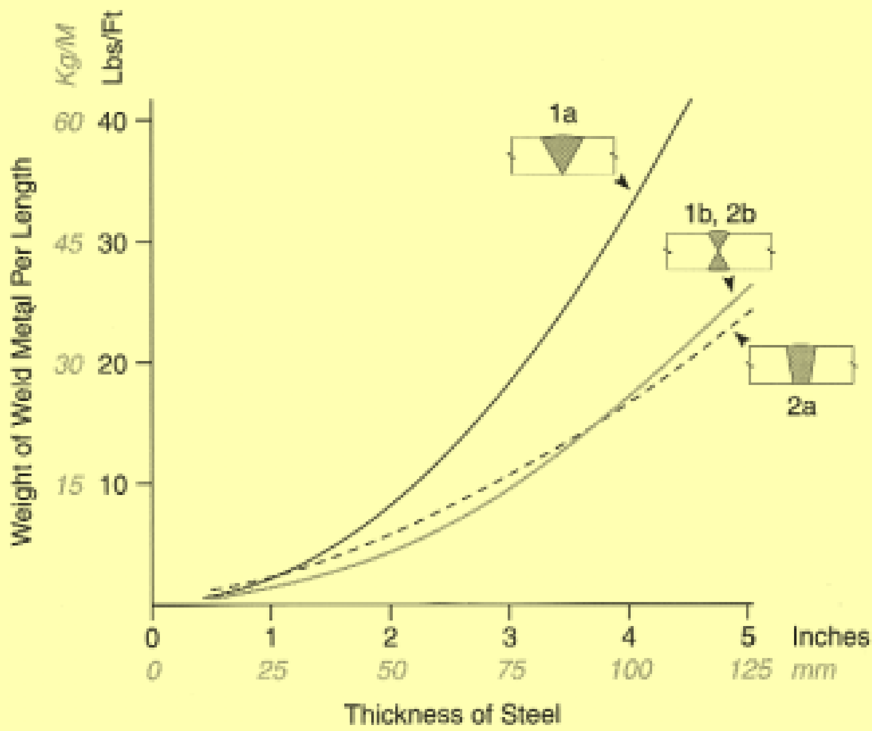

3
4
2
1
5
6
7
8
3a
7
8
4
1
2
3
5
6
3b

Figure 3


Kg/M
Lbs/Ft
Weight of Weld Metal Per Length
60
40
45
30
30
20
15
10
1a
1b, 2b
2a
0
1
2
3
4
5
Inches
0
25
50
75
100
125
mm
Thickness of Steel

Weld Metal Deposition Rates

The root pass of most joints is the most difficult portion of the weld to make. Deposition rates for fill passes generally can be higher than for root passes. Because double sided joints have, in essence, two root passes, the average deposition rate for a single sided joint may be higher than that of a corresponding double sided joint. If the double sided joint requires out-of-position welding, deposition rates will obviously decrease. For example, overhead deposition rates can be assumed to be about ¹⁄₁₀th those of downhand welding.

Backgouging Operations

The *Dl.1 Code* requires backgouging on prequalified double sided joints to provide assurance of complete through-section fusion. In addition, the gouged groove must be back filled with quality weld metal.

Weld Quality

The fact that the double sided joint requires two difficult-to make root passes makes it unlikely that the reduced weld volume will result in fewer weld discontinuities.

Distortion Control

Reducing weld volume will naturally reduce longitudinal shrinkage. Regarding angular distortion, double sided joints offer advantages provided that proper welding sequence is followed. This requires balancing the shrinkage forces of the individual weld beads about the center line of the plate. The first sequence (**Figure 3a**) would result in significant angular distortion. **Figure 3b** shows the proper sequence that will result in a flatter joint.

Examples

To illustrate the potential problems that can occur when double sided joints are specified without critical analysis, the graph shown in **Figure 4** was developed. If joint preparation cost is assumed to be the same for each detail, material handling and backgouging costs are ignored, and deposition rates are considered constant for all passes and all weld types, the relative differences in weld volume should relate to approximate differences in costs. These other issues, however, must be examined.

The simple groove welds illustrated in **Figure la and lb** demonstrate the 2:1 ratio. For the two prequalified details (**Figure 2a and 2b**), the ratio is clearly not 2:1, and in the case of steel thicknesses greater than ³⁄₄", the single sided groove weld actually requires less weld metal than the double sided option.

Conclusion

There are distinct advantages for some double sided groove weld preparations versus single sided details. The difference, however, is not necessarily a two-to-one savings, and depending on the particular geometries involved, single sided weld joints may be the more cost effective choice in some situations. The designer of the joint must select optimum details in close consultation with the fabrication department. Simply specifying the use of double sided groove welds is not enough.

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