Design File

Use Caution When Specifying “Seal Welds”

Practical Ideas for the Design Professional by Duane K. Miller, Sc.D., P.E.

Introduction

What is a “seal weld?” *AWS A3.0, Standard Welding Terms and Definitions*, defines a seal weld as: “Any weld designed primarily to provide a specific degree of tightness against leakage.” The purpose of a seal weld may be to contain a fluid – either gaseous or liquid. In the mechanical and structural fields, seal welds are used most often not to prevent leakage out of a container, but to prevent entry of a fluid into a space where some type of harmful behavior, often corrosion, is expected to occur. In these fields, seal welds are frequently used to preclude moisture and oxygen-laden air and water from entering that cavity.

Seal welds may be specified on parts to be galvanized to prohibit pickling acids and/or liquid zinc from entering into a specific region. For architecturally exposed steel that is to be painted, seal welds may be specified to prevent unsightly rust bleeding. Seal welds may be required for some applications where the sealed joint is more conducive to cleanup than an exposed joint would be. Food processing facilities are one such example.

The characteristic common to all of the aforementioned examples of seal welds is as follows: none of them are placed for traditional strength-related reasons, and for this reason, caution should be exhibited when seal welds are specified. In some cases, the application of a seal weld may result in a conflict of code requirements. In others, the seal weld may perform structural functions that were unintended, resulting in undesirable load paths. Seal welds may affect inspection practices, in particular, the interpretation of ultrasonic inspection results. Finally, seal welds may be treated in a casual manner by those responsible for making them, resulting in weld quality problems. Each of these examples will be examined, as will be some issues related to galvanizing that need to be considered as well.

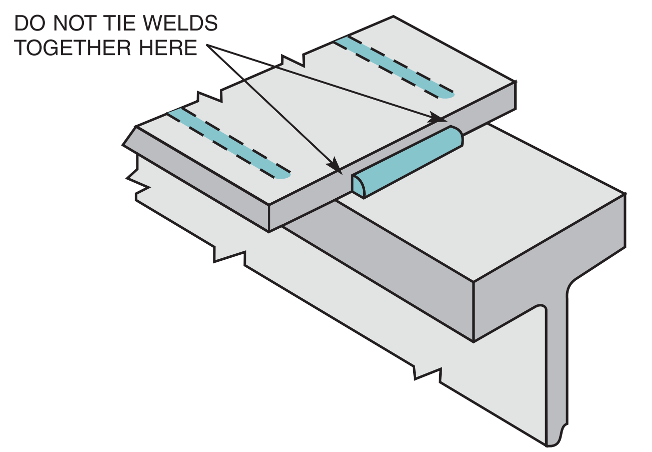

Figure 1.

Code Conflicts

A common inquiry is as follows:

> “The drawings call for seal weld, but in order for me to comply with that requirement, I need to violate *AWS D1.1-98*, Section 2.4.7.5. What should I do?”

The specific code provision cited is the one that calls for the interruption of welds which occur on opposite sides of a common plane, and under these conditions, the welds are required to be interrupted at the corner (Figure 1). This provision has a practical foundation: it is difficult to make a continuous weld in these conditions, and the probability of undercutting the corners is great when the welds are made continuous. This is one problem associated with seal welds when applied to these situations.

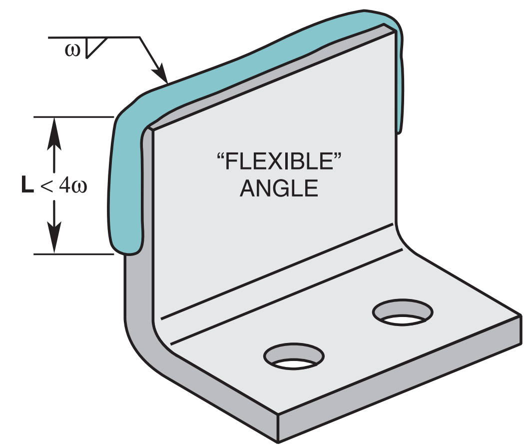

Figure 2.

Other code provisions can be violated, including *AWS D1.1*, Section 2.4.7.3, which addresses “flexible connections” that rely on the flexibility of the outstanding leg of angles (Figure 2). Examples would include framing angles, top angles of seated beam connections, and simple end plate connections. A seal weld around a flexible connection reduces such flexibility and may change the overall behavior that is expected.

AWS D1.1, Section 2.4.7.4, calls for welds on stiffeners to be cut short not less than 4 times, nor more than 6 times, the thickness of the web from the weld toe of the web-to-flange welds (Figure 3). This provision was incorporated to provide for a degree of flexibility in this region. Previous experience in shipping had shown this to be an area that was prone to cracking when the weld extended too far. Seal welds applied to this area effectively preclude such flexibility.

$4t_w \leq L \leq 6t_w$

where,

L = length of unwelded stiffener

t_w = weld thickness

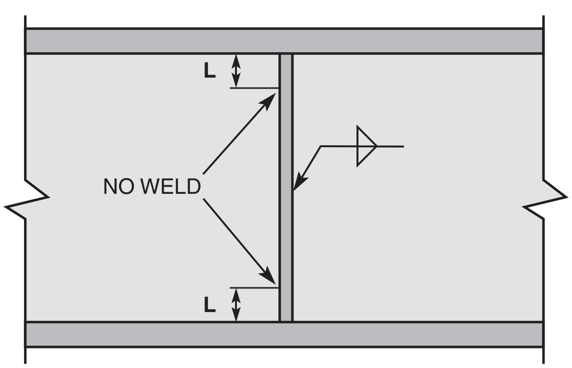

Figure 3.

The designer who calls for a seal weld should review these code provisions if the project is governed by the D1.1 code, and in the situations where the code is not applicable, examine these principles and determine their relative suitability to the components where seal welding has been utilized. To handle the issue of consistency between job specifications and code requirements, the engineer can address how these issues are to be resolved in the project specifications. The preceding list of code examples is illustrative only, and may not be comprehensive in its coverage of issues where seal welding requirements may violate code provisions.

Alternate Load Paths

The second major series of problems associated with seal welds involves those applications where unintended load paths are created. For example, a lapped connection may be joined by bolts with no welds expected at all. However, a seal weld is specified around the connection. *AWS D1.1*, Section 2.6.3, may be applicable in this situation. In bearing connections, the code does not allow bolts and welds to share the load. Of course, in this particular situation, the designer would probably not consider the seal welds as members that would share loads with welds, but in fact, they will. The seal welds would be small in size and probably incapable of transmitting the applied loads by themselves. In actual service, the first thing that would happen would be for the welds to fracture, violating the purpose of the seal weld, before the bolts would load up and carry the transferred forces.

The welding adage, “There are no secondary members in welded design,” is applicable when considering seal welds. An example arose several years ago where a tub-type rock crusher had been designed with a series of stiffeners. The detailing had been carefully thought through so as to avoid stress risers. A stainless steel nameplate was to be applied to the unit, and a seal weld was called for to attach this nameplate. The entire unit received a special, multi-coat paint system to preclude corrosion, and the seal weld ensured that the material under the stainless steel nameplate would not be exposed to the elements. The nameplate was put into a high stress region, and whether intended or not by the designer, the nameplate became part of the load bearing system, and the weld introduced residual stresses as well.

The seal weld around the nameplate became the design-limiting fatigue detail that resulted in crack initiation in service. The intention of the designer was circumvented by an ill-conceived plan for a seal weld around a nameplate. In this particular example, any weld (including an intermittent weld) may have created a poor fatigue detail.

Casual Treatment of Seal Welds

The minimum heat input requirements imposed by *AWS D1.1* may be violated when the seal weld is made. Table 5.8 of that code prescribes certain minimum sizes of welds that must be maintained, regardless of the level of loading, in order to ensure that adequate heat input is achieved when the weld is made. The size of the seal weld may not be specified, resulting in a weld that would otherwise be disallowed by Table 5.8. It is still important that good welding practices be followed when seal welds are made, including adherence to the minimum fillet weld size. Failure to do so may result in weld cracking or incomplete fusion defects.

The welder who is charged with the responsibility of making a seal weld may approach it in a very casual manner, as might the welder's supervisor. The welder should have the same qualifications as the welder charged with the responsibility for making a similar weld that would have a structural purpose. The welding procedures, including the selection of the electrode and the required preheat level, are deserving of the same attention as a weld that transfers calculated loads. The claim "It is only a seal weld" is often a prescription for problems.

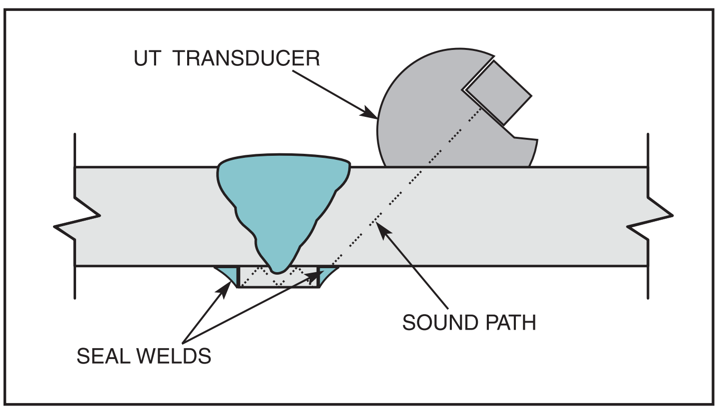

Figure 4.

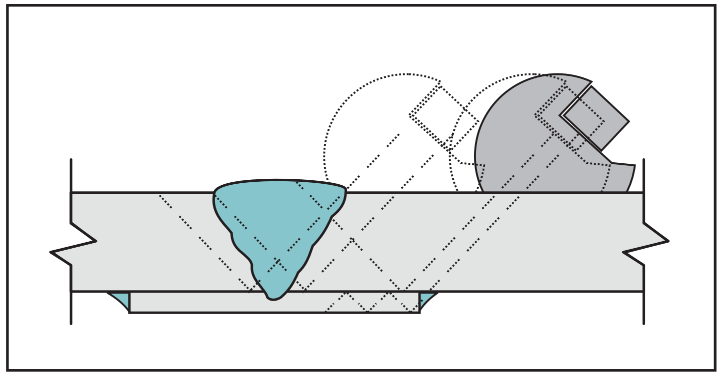

Figure 5.

Inspection Issues

The presence of seal welds around steel backing that is left in place after welding may have implications for the ultrasonic testing (UT) of such connections. Consider Figure 4 in which a CJP groove weld with steel backing is inspected with UT. An alternate sound path is created when the seal welds are placed around the left-in-place backing. Such implications should be understood before inspection begins.

If backing is to be seal welded to the base material, then one may consider making the backing a little wider (Figure 5). With the seal welds further from welded joint, the UT sound waves will have a better opportunity to "see" the root without secondary reflections through the seal welds.

Galvanizing Issues

One of the more common applications for seal welds is in assemblies that are required to be hot dip galvanized (Figure 6). The American Galvanizers Association (AGA) defines three classes for welded assemblies that will be galvanized. Class 1 Joints are held together by a full seal weld. Class 2 Joints are held together by seal welds, but the overlapped area is large enough to require venting, i.e., provision of an escape hole for the release of expanding trapped gases. Class 3 Joint details do not contain seal welds.

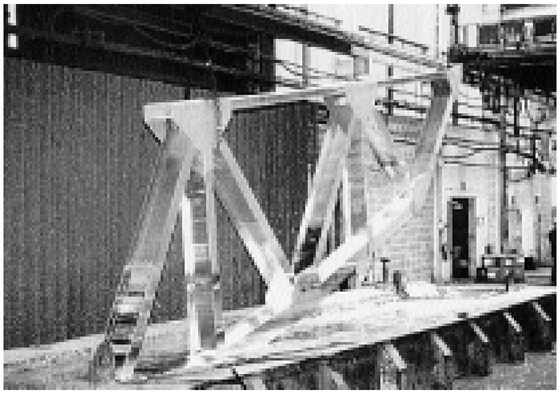

Figure 6.

Figure 7.

Figure 8.

AGA documents require a vent to be provided whenever the overlapping area exceeds 16 in^2 (100 cm^2). Specific diameters of the holes and locations are also spelled out. Thus, a Class 1 detail is only applicable for an overlapped area of 16 in^2 (100 cm^2) or less. Class 1 represents "the highest degree of corrosion protection that is attainable," and while Class 2 is "not quite equal to Class 1," it is possible to plug the vent hole after galvanizing to upgrade a Class 2 to Class 1.

Class 3 details provide "a degree of corrosion protection that meets or exceeds the protection provided by most industrial coatings." It is noted that the unsealed overlaps from Class 2 and 3 details may stain the surface of the coating, or steaming from unsealed overlaps may result in slight bare spots along the line of the exhaust.

Special caution is noted for Class 1 seal applications because porosity may result in an explosion as trapped liquid-acid vaporizes and expands when the part is dipped into the hot zinc. Venting minimizes that concern.

This edition of Design File is not intended to be a treatise on galvanizing and preferred details for corrosion resistance. However, it does identify concerns that are associated with seal welding and the galvanizing practice. The user is encouraged to review AGA documents in this regard. The American Galvanizers Association can be contacted through their website at www.galvanizeit.org, or by phone at (800) 468-7732.

Conclusions

Seal welds can perform an important function both in containing fluids, and in precluding the entry of fluids into regions where harmful effects can result. However, seal welds also can unintentionally cause differences in the structural behavior of the attached members, and the designer should be aware of these potential interactions. The welding practices employed when seal welds are made should not be any different than those associated with welds that are designed to carry loads. When seal welds are applied to galvanized assemblies, caution should be taken to make sure that venting is appropriate, and for Class 1 Joints where vents are not required, that the weld is "porosity-free" so that no seepage is experienced. Once seal welds have been carefully thought through, the designer needs to clearly communicate in the job specifications how the fabricator is to deal with code restrictions which may specify practices that are inconsistent with seal welding.