DOI: 10.1017/S1431927605509747
Microsc Microanal 11(Suppl 2), 2005

Effect of FSW Process and Parameters on Corrosion Susceptibility

E. Litwinski, Senior Engineer/Scientist
Failure Analysis & Metallurgy Labs, Material & Process Engineering
The Boeing Company, 5301 Bolsa Avenue, Huntington Beach, CA 92647-2099

The primary consideration when developing parameters and processes for Friction Stir Welding (FSW) has been weld mechanical properties (i.e., ultimate and yield tensile strength and elongation). In general, lowering the weld-cooling rate through faster welding speeds and active external cooling tends to increase weld strengths. Additionally, the applications of post weld artificial aging results in increased weld strength.

Corrosion resistance as influenced by welding parameter (travel speeds) and processes (active heating, cooling and room temperature welding) was assessed by subjecting weld specimens to a 90 day unstressed alternate immersion test and comparing the losses in ultimate weld strength in 2195-T87A3 aluminum-lithium alloy and 7150-T7751 aluminum alloy welds.

The analysis determined that the Thermo-Mechanical Affected Zone, adjacent to the weld nugget region, was most susceptible to corrosion. The corrosion resistance can widely vary depending on changes to the welding parameters and process. The artificially aged specimens tended to have a greater variation in corrosion effect as well as a higher loss in strength due to corrosion. In 2195-T8A3, the effect of welding process and parameters resulted in a 5% to 40% loss in ultimate strength due to corrosion. In 7150-T7751, the effect of welding process and parameters resulted in a 24% to 44% loss in ultimate strength due to corrosion.

This variation in corrosion resistance is primarily attributed to sensitivity of aluminum alloys affected by quench rate after solution heat treatment. A thermal profile of a weld indicated that the TMAZ region was approximately 850 °F, sufficient to place the TMAZ into a partially solution heat-treated condition. The welding cooling rates ranged from 9 to 54 °F/sec. Generally, a 500 °F/sec quench rate is required to produce maximum corrosion resistance. At lower quench rates, aluminum alloys have a greater susceptibility to corrosion, especially when quenched in the 50-100 °F/sec range. Additionally, the grains in the TMAZ are oriented in the transverse direction at the surface, furthering the effects of corrosion it this region.

The testing determined that the weld travel speed/cooling rate has an appreciable effect on the weld corrosion resistance. Some combinations of weld travel speeds and conditions had a greater susceptibility to corrosion. This was especially obvious after a post weld artificial age. However, it was also determined that other combinations of weld travel speeds and conditions produced welds with no appreciable difference in corrosion susceptibility as compared to the base metal.

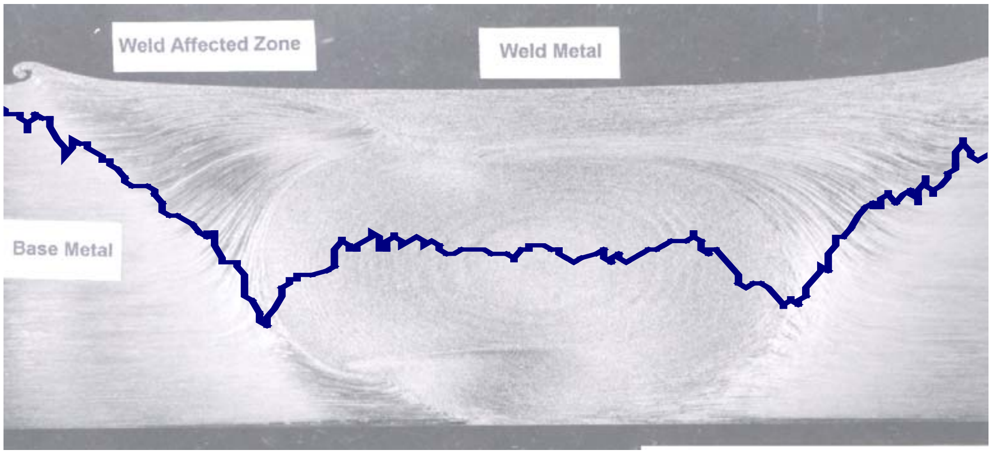


Fig. 1. Image of typical FSW (2195-T8A3) with a hardness profile overlay.

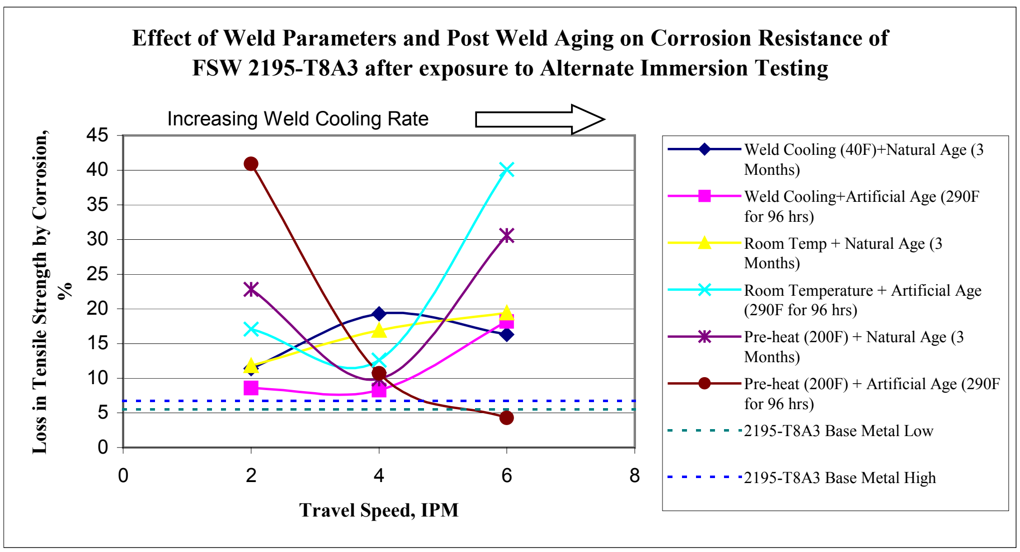
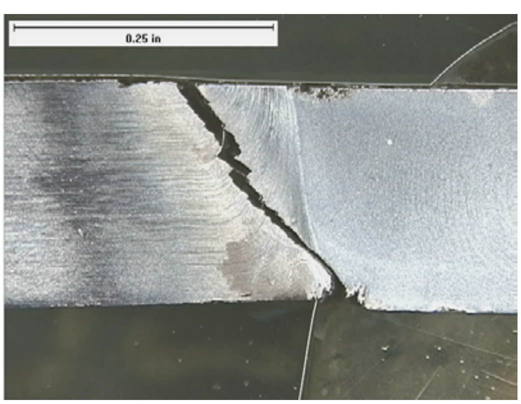
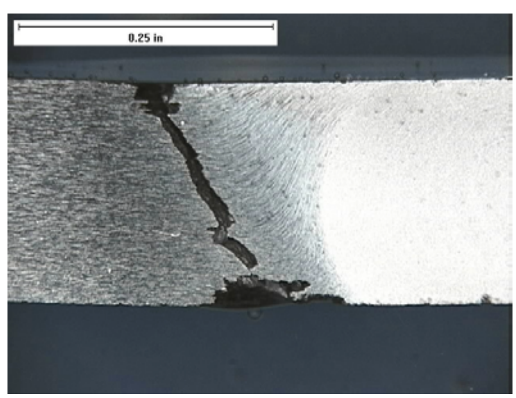


Fig. 2. Effect of Weld Parameters and Post Weld Aging on Corrosion Resistance of FSW 2195-T8A3 after Alternate Immersion Testing





Figs. 3 and 4 (left and right). Typical micrographs of 2195-T8A3 and 7150-T7751 FSW tensile specimens after alternate immersion testing.

https://doi.org/10.1017/S1431927605509747 Published online by Cambridge University Press