Residual Stress in Friction Stir Welded Aluminum Alloys

J.A. Pineault*, M. Belassel*, H.J.K. Lemmen**, M.E. Brauss***

*Proto Manufacturing Ltd., Oldcastle, Ontario, N0R 1L0, Canada
**Delft University of Technology, Delft, P.O. Box 5058, 2600 GB, the Netherlands
***Proto Manufacturing Inc., Ypsilanti, MI, 48198 U.S.A.

ABSTRACT

Recent advancements in friction stir welding (FSW) technology have enabled its use in numerous joining applications and it has recently been approved by the Federal Aviation Administration (FAA) for applications in aerospace structures. FSW features many advantages including the potential for a reduction in production costs, lead-times, and a decrease in structural weight while maintaining a high strength, high quality joint. The residual stress fields in several FS welds using three different aluminium alloys, AA2024-T3, AA7075-T6 and AA6013-T4, in the as-welded condition were measured using x-ray diffraction (XRD) techniques. Selected welds were also characterized in the as-machined condition as might be found in a typical aircraft structure. The residual stress profiles in all three welded alloys exhibited high tensile stress fields in the weld with a width comparable to the tool size. In areas adjacent to the weld, the residual stress levels were reduced to either zero or low magnitude compressive levels. It was observed that both AA2024-T3 and AA7075-T6 had comparable residual stress profiles, whereas AA6013-T4 was found to have relatively lower magnitude residual stresses. The findings described in the following paper indicate that an awareness of the residual stresses present in FS welds is necessary to ensure successful implementation of FSW in failure critical structures.