Friction Stir Welding of the Advanced Amphibious Assault Vehicle

by Tim Trapp and Tim Stotler, Edison Welding Institute

Introduction

This abstract describes a Navy Joining Center project to develop and demonstrate friction stir welding (FSW) for joining Aluminum 2519-T87 armor on the Advanced Amphibious Assault Vehicle (AAAV). Alloy 2519, which is known for high strength and superior ballistic performance, is being used on the Marine Corps' AAAV. General Dynamics Land Systems (GDLS), the AAAV Program Office, and Edison Welding Institute (EWI) conducted the project. This project supports the AAAV program by developing procedures to improve productivity, reduce acquisition costs, reduce weld distortion, and maximize ballistic performance.

The goals of the FSW program were to 1) produce welds with equivalent or greater strength, and increased ductility compared to conventional arc welds, and 2) to fabricate and successfully test ballistic weld samples. NJC efforts included development of robust FSW tools, of optimal butt welding procedures for the range of material thickness, of a FSW distortion process model, and of procedures for groove, corner, and t-joint configurations. The project will provide FSW tooling concepts, determine machine requirements, and develop robust procedures and production methods to support efficient vehicle production.

FSW, which was developed by The Welding Institute (TWI) has been shown to produce superior as-welded mechanical properties when compared to typical arc welding processes in other aluminum alloys such as 2219, 2195, 5083, 6061, and 7050. FSW operates by passing a rotating tool between two plates that are restricted from movement. The tool is pushed down (plunged) into the material to a preset depth or load. Once plunged, the tool is moved along the weld seam. A pictorial description of the process is shown in Figure 1.

Heat is generated through frictional contact between the rotating tool shoulder and the abutting material surface. All welding takes place in the solid state, minimizing the typical distortion and mechanical property losses associated with traditional arc welding processes.

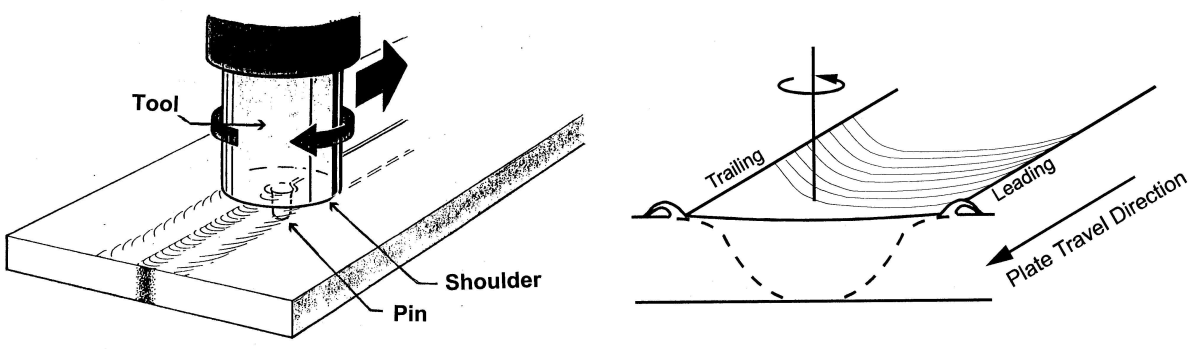

Figure 1. FSW Pictorial Description

Conclusions

- The FSW process was developed to make single pass joints in 2519 –T87 armor plate on the 0.5, 1.0, and 1.5-in. thickness.

- FSW mechanical properties were found to have greater strength and twice the ductility when compared to conventional GMAW properties.

- FSW butt welds successfully passed ballistic qualification testing for 2519-T87 aluminum. Successful ballistic performance is believed to be associated with increased ductility.

- Due to process refinements, single pass 1-in. thick FSWs were produced at travel speeds in excess of 4.5 IPM, which doubled productivity compared to the initial 2-pass procedure that passed ballistic testing.