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Performance Improvement of Friction Stir Welds by Better Surface Finish

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Sponsoring Program(s)

Human Exploration and Operations Mission Directorate
Space Launch System Advanced Development

Project Description

The as-welded friction stir weld has a cross section that may act as a stress concentrator. The geometry associated with the stress concentration may reduce the weld strength and it makes the weld challenging to inspect with ultrasound. In some cases, the geometry leads to false positive nondestructive evaluation (NDE) indications and, in many cases, it requires manual blending to facilitate the inspection. This study will measure the stress concentration effect and develop an improved phased array ultrasound testing (PAUT) technique for friction stir welding.

Post-welding, the friction stir weld (FSW) tool would be fitted with an end mill that would machine the weld smooth, trimmed shaved. This would eliminate the need for manual weld preparation for ultrasonic inspections. Manual surface preparation is a hand operation that varies widely depending on the person preparing the welds. Shaving is a process that can be automated and tightly controlled.

Notable Accomplishments

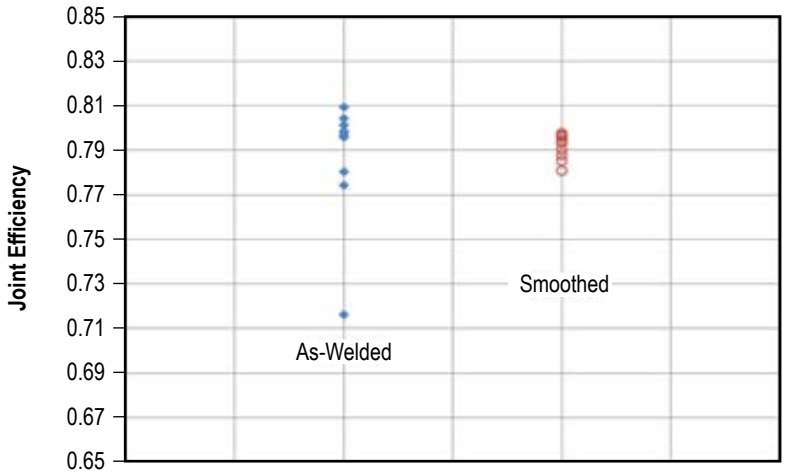
Two sets of panels will be welded with FSWs. One set will be prepared in the usual manner; the second set will be shaved by milling. These panels will be used to estimate the phased array testing detectability of defects in the surface. The defects will be electro-discharge machining (EDM) notches placed in and along the weld. Then samples will be cut from these panels and pulled in a tensile test machine to measure the strength of the shaved and unshaved panels.

The baseline self-reacting-friction stir weld (SR-FSW) panels include (a) eight baseline panels that have been welded and PAUT tested, (b) two baseline panels that have been machined into tensile specimens for room temperature, liquid nitrogen (LN_2), and liquid hydrogen (LH_2) testing; this work is complete, (c) five baseline panels that have been laid out for EDM notches; this work is complete, and (d) one EDM notched baseline panel that has been given to EM10 to measure the notches; however, they are having trouble measuring the notches. A few work-arounds are currently being assessed.

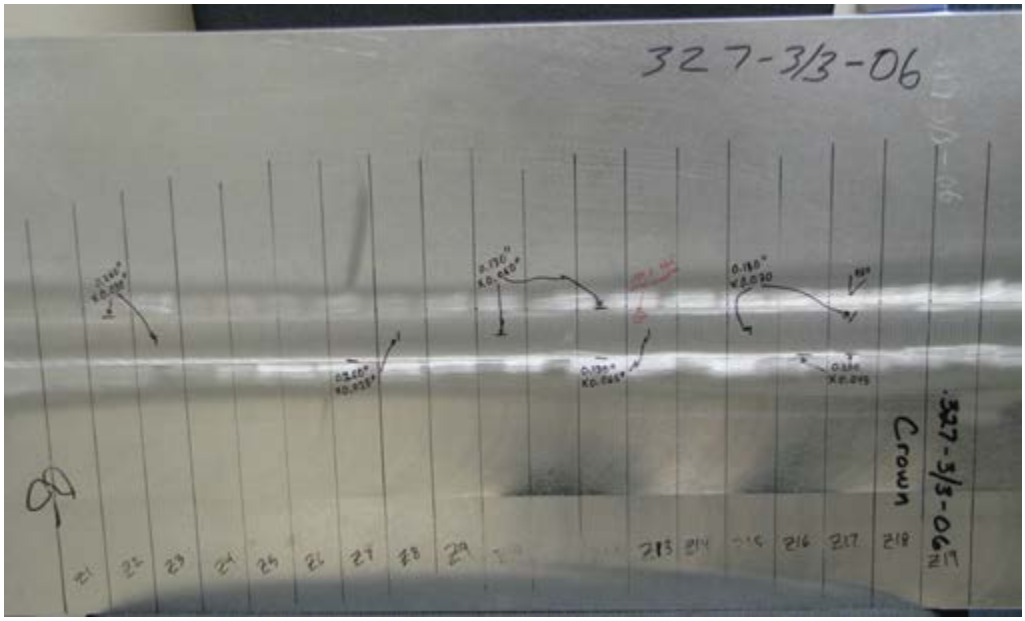
The SR-FSW panels with raised weld land (~0.025 inch) include (a) one panel with raised weld land, welded to determine the best method for machining the raised weld-land, (b) seven panels with raised weld land have been welded and PAUT inspected; these panels had a slight ridge that was not machined off and was hand sanded to remove the slight ridge, then reinspected with PAUT (five panels were identified for probability of detection inspections), (c) two panels with raised weld land have been machined into tensile specimens for room temperature, LN_2, and LH_2 testing; this work is complete, and (d) five panels with raised weld-land have been laid out for EDM notches; the work has been scheduled.

References

Crumbly, C.M.; Bickley, F.P; and Hueter, U.: “Space Launch System Spacecraft/Payloads Integration and Evolution Office Advanced Development FY 2014 Annual Report,” NASA/TM—2015–218201, NASA Marshall Space Flight Center, Huntsville, AL, January 2015.



Joint efficiency of welded panels at room temperature.



Welded panel.