New Techniques for Enhanced Friction Stir Welding of Novel Joints

PUBLISHABLE SUMMARY

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Background

The friction stir welding (FSW) process was invented by TWI in 1991, and originally developed for industrial exploitation via a TWI Group Sponsored Project (GSP). This solid-state joining process is used when the original metal characteristics must remain unchanged as much as possible.

Recently TWI has developed a novel enhancement to this FSW process which offers the potential to make FSW joints in geometries that have not been possible to date, thereby greatly extending the design opportunities. This technique offers the possibility to join difficult to extrude/weld aluminium alloys into fabricated sections with tailored properties and improved performance. This GSP was proposed to develop, evaluate, and demonstrate the capabilities and benefits of this new technique. Participants in the GSP were placed to become early adopters of the new technique and to benefit from the enhanced capabilities that it offered.

TWI Ltd, Granta Park, Great Abington, Cambridge CB21 6AL, UK. Tel: +44 (0)1223 899000

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Objectives

The overall project had the following objectives:

- Demonstrate the feasibility of applying fillet corner welding to a range of commercially available aluminium alloys and section thicknesses chosen by the sponsors.
- Assess the performance of different tool designs.
- Assess weld stability and process reproducibility.
- Determine the process requirements in terms of fixturing, FSW machine tool requirements, set-up alignment and gap tolerances.
- Evaluate selected joint properties of welds made using corner welding techniques compared with competing technologies.
- Apply the developed technology to prototype plates.
- Assist in the development of business cases for the adoption of FSW where appropriate.

Project Outcome

This project is now complete

Benefits

- Information to allow evaluation of the SSCFSW and AdStir techniques to aid in the justification of early adoption of the technology.
- Knowledge of new welding techniques which have the potential to:-
  - Extend the use of FSW and greatly broaden design possibilities;
  - Fabricate structures with tailored properties providing light weighting opportunities;
  - Fabricate sections in aluminium alloy grades which are impossible to extrude;
  - Fabricate joints with improved static and dynamic mechanical properties.

The work that was carried out and the results and conclusions reached would remain confidential to the Sponsors. This would give the Sponsors the potential to gain a commercial advantage over their competitors not participating in this project.

Participants

The Sponsor Group at the completion of the project comprised:

- AVIC Beijing Institute of Aeronautical Materials;
- BAMTRI;
- Embraer SA;
- ESAB AB;
- Furukawa-Sky Aluminium Corporation;
- IHI Corporation;
- Kawasaki Heavy Industries;
- Mitsubishi Heavy Industries Ltd;
- Nippon Light Metal Company Ltd;
- Nippon Sharyo Ltd;
- STRI (China).

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Scope of Work

The project developed a new FSW technique based on stationary shoulder FSW but also included adding a filler material to form reinforced fillet corner welds. This technique is called AdStir.

The work scope was split into three distinct categories based around different aluminium alloy grades, thicknesses and potential applications

AA6xxx: Plate thicknesses of 4, 8, and 10mm

AA5xxx: Plate thicknesses of 4, 12, and 16mm

AA7xxx and AA2xxx: Plate thicknesses 1.6, 4, 8mm

Initially a universal fixture was designed and manufactured to fabricate T components nominally 400 x 100 x 75mm. Process parameters, tooling and methodology are being developed to produce both fully and partial penetrating corner welds with a variety of fillet geometries in the aluminium grades and thicknesses stated above. The weld quality was assessed through sectioning and tensile strength testing.

A new AdStir welding head had been designed and manufactured within the project with enhanced capabilities to explore welding thicker sections and increased processing speeds.

Tolerance to imperfect component interface fit up was also investigated by introducing simulated gaps between the plates to assess the capability of the AdStir process to produce the fillet and also fill these gaps.

Price and Duration

The project had duration of three years and a budget of £440,000. There were 11 Sponsors each making a contribution of £40,000. The cost for additional Sponsors to buy back into this work is £40,000.

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

http://www.twi.co.uk/services/research-and-consultancy/joint-industry-projects/

GSP Co-ordinator: Kirsty Jones **Ref:** 20519/16-1/13

Email: jip@twi.co.uk

Project Leader: Naveed Iqbal

Email: Naveed.iqbal@twi.co.uk