Friction Stir Welding
Agenda

I. Welding Method Overview
II. Friction Stir Welding Process
III. Examples of FSW
IV. Current R & D Projects
Welding Methods

Common methods:
- Metal Inert Gas [MIG]
- Tungsten Inert Gas [TIG]
- Friction Stir Welding [FSW]

Less common methods:
- Laser welding
- Hybrid methods
- Explosive welding
- Magnetic pulse welding
- Friction Welding
- Resistive spot welding
- Friction Stir Spot Welding
- Plasma welding
MIG Welding Method

- High production method
- Continuous feeding of fill material.
- Manual or automatic.
- Most used in thicker goods (>2 mm)
- Somewhat operator dependent
TIG Welding Method

- Low productivity
- High quality
- Fillet material can be used
- Manual or mechanized
- Application mostly in thinner goods (<3 mm)
- Highly operator dependent
FSW
Friction Stir Welding
FSW at Sapa

- 1990 First FSW trials at TWI
- 1991 First patent application from TWI
- 1993 GSP formed
- 1994 First FSW weld at Sapa
- 1995 First order! “Freezing plate”
- 1997 First FSW-machine to Sapa
- 1997 First order in the new machine. Ericsson
- 1999 Second FSW-machine. ABB Power Systems
- 1999 Third FSW-machine. Autoliv
- 1999 Long-length machine installed
- 2000 Industrial production long-length FSW
- 2003 FSW-machine in Holland
- 2005 FSW-machine in Shanghai
- 2005 Approximately 1000 m/day being welded
- 2008 Approximately 2000 m/day being welded
Friction Stir Welding Method

- Strong backing
- High demand of fixation (tolerances, handling)
- Rigid machine
- Solid state process
- No Melting
Need to contain the softened material

- Softened material must be contained by parent material, FSW tool shoulder or backing bar (anvil):

![Diagram showing the containment of softened material]
Typical top face of the weld
FSW – Weld Structure
FSW – Hardness Profile Across Weld

![Graph showing hardness profile across a weld. The graph compares as-welded and aged (3h at 185°C) conditions.](image-url)

**En-AW 6082-T6**
UTS - EN-AW 6082
Different combinations of welding and ageing

Stress [Mpa]

Bas-material T6  FSW T6  FSW T6+ Re-aged  Bas-material T4  FSW T4  FSW T4+ Re-aged
Typical FSW Joint Geometries
Typical FSW Joint Geometries
Design The Profile

Edge preparation integrated into profile design – the illustration also features material compensation for strength reduction in the weld zone.

Placing of welds in lower stress sections of the cross sectional area. This results in fewer welds, and butt rather than fillet welds.

Permanent root backing.

In-built fastening – used in dry environments.

Number of welds reduced from 12 to 4 – butt welds rather than the weaker fillet welds (which are also harder to x-ray). Fewer components, reduced welding (consequently fewer heat-affected zones) and straightening minimised.
Transit Car Assemblies
Marine Applications

Aluminium panels for ship decks, hulls, bulkheads, balconies, roofs, etc. in:

- Mega yachts
- Cruise ships
- High speed ferries
- Military vessels
Marine Applications - Examples
Telecom Applications - Heat Sinks

Liquid cooler: body and lid before and after FSW
Civil Engineering Applications - Example

Aluminium bridge decks
Cost Comparison

- Simple Answer –
  - It Depends

- Longer Answer – Factors to Consider
  - Design Changes
  - Cost of Consumables
  - Post Weld Clean-Up
  - Quality Issues
  - Appearance
Friction Stir Welding - Advantages

- Solid state
- Reliable method
- No added material
- No shielding gas
- Low heat input
- Low thermal distortion of joints
- High tensile properties in heat treatable alloys
- Suitable for automation
- Cost effective
- Sapa has FSW experience since 1996
Place to find further information:  
http://www.eaa.net/eaa/education/talat/


Sapa Technology / www.sapagroup.com

The Aluminium Association (AA) aluminum.org

Sasak.dk (Danish project – joining of large aluminium constructions)

Goda råd vid aluminiumsvetsning, Svetskommissionen (svets.se) (in Swedish)
Questions?
Sapa is environmentally conscious with regenerative equipment and reduced solvent and waste components. Sapa products meet or exceed AAMA specifications.

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