sapa:

FSW

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:

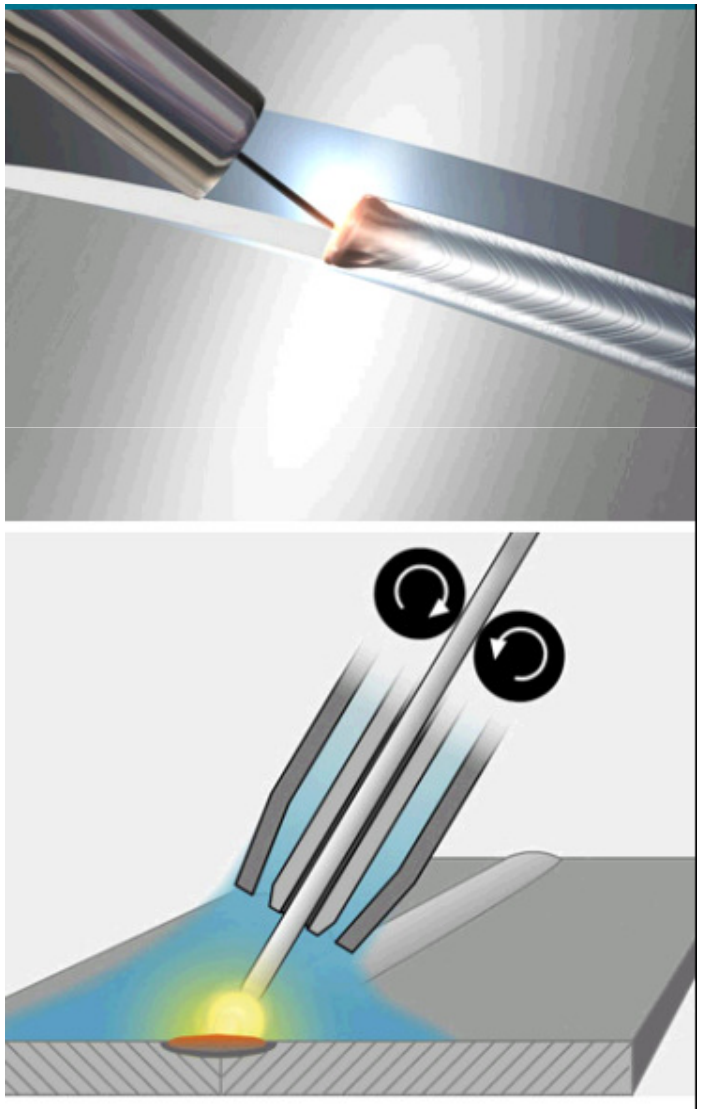
- Metal Inert Gas [MIG]
- Tungsten Inert Gas [TIG]
- Friction Stir Welding [FSW]

Less common methods:

- Laser welding
- Hybrid methods
- Explosive welding
- Magnetic pulse welding
- Friction Welding
- Resistive spot welding
- Friction Stir Spot Welding
- Plasma welding

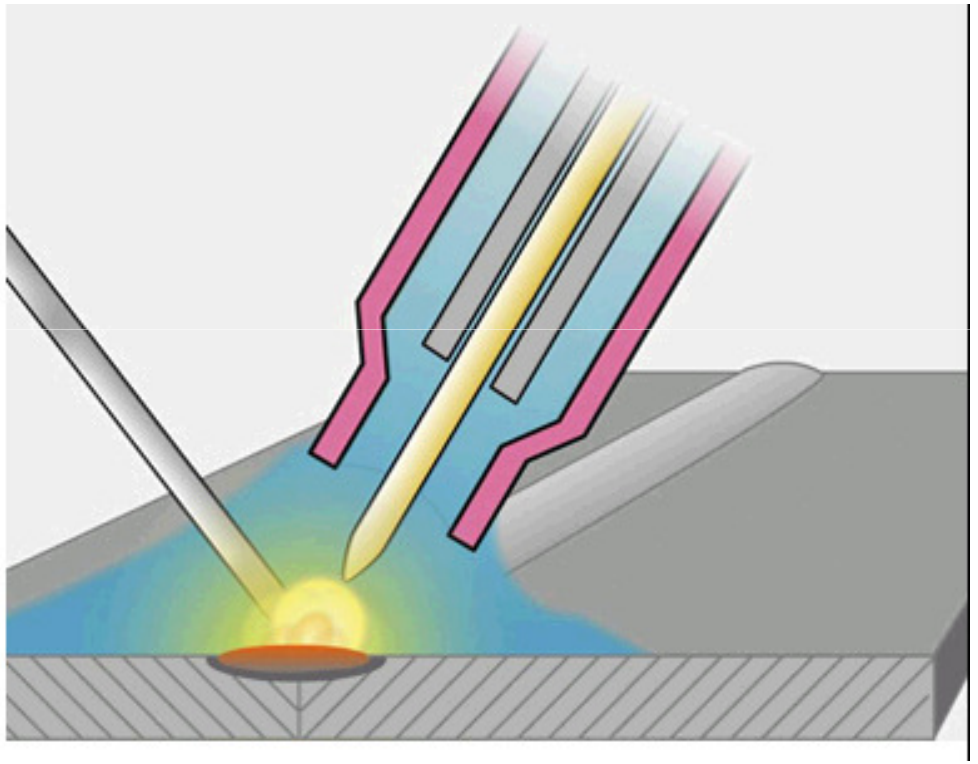
MIG Welding Method

- 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

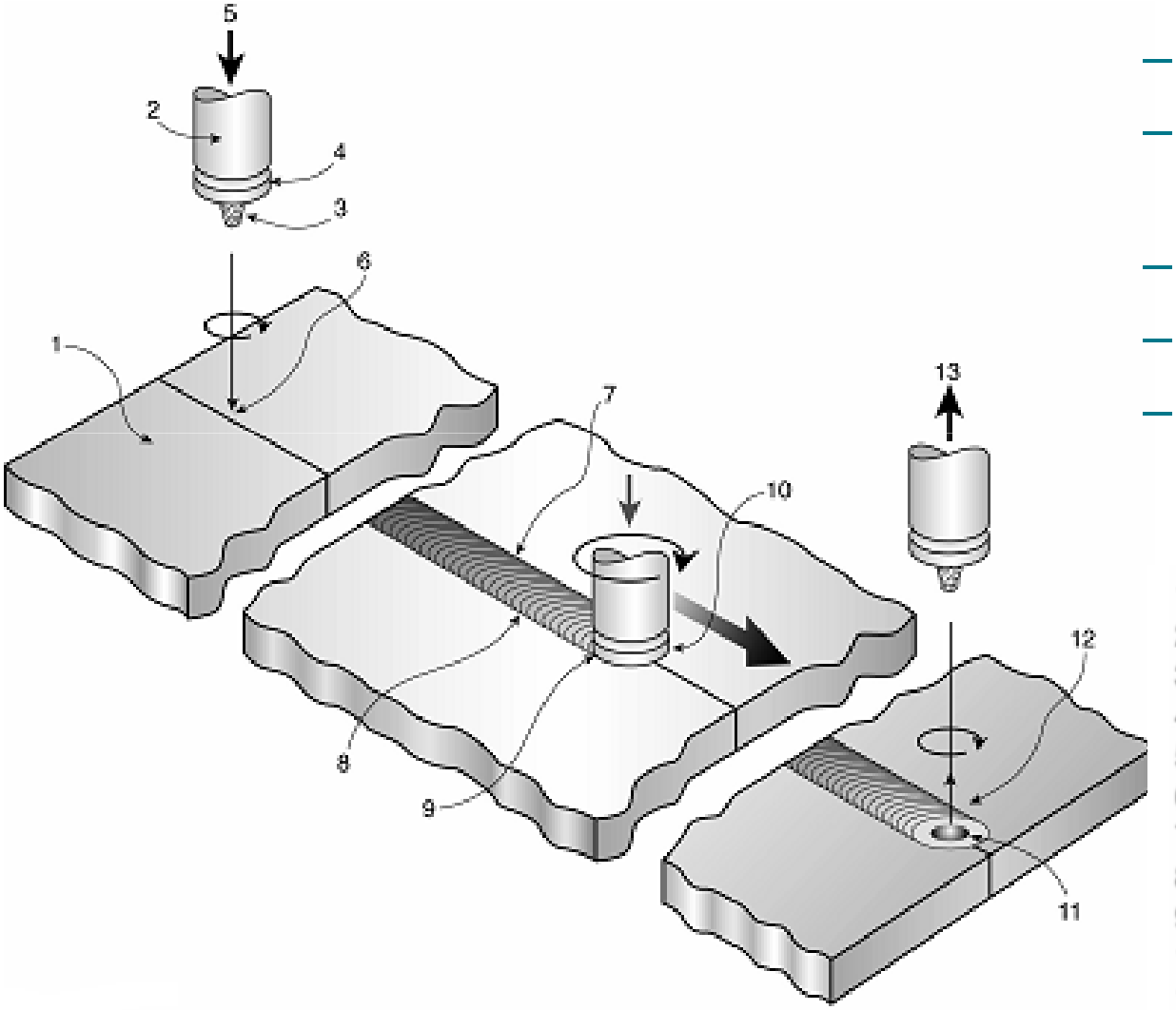


FSW
Friction Stir Welding

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

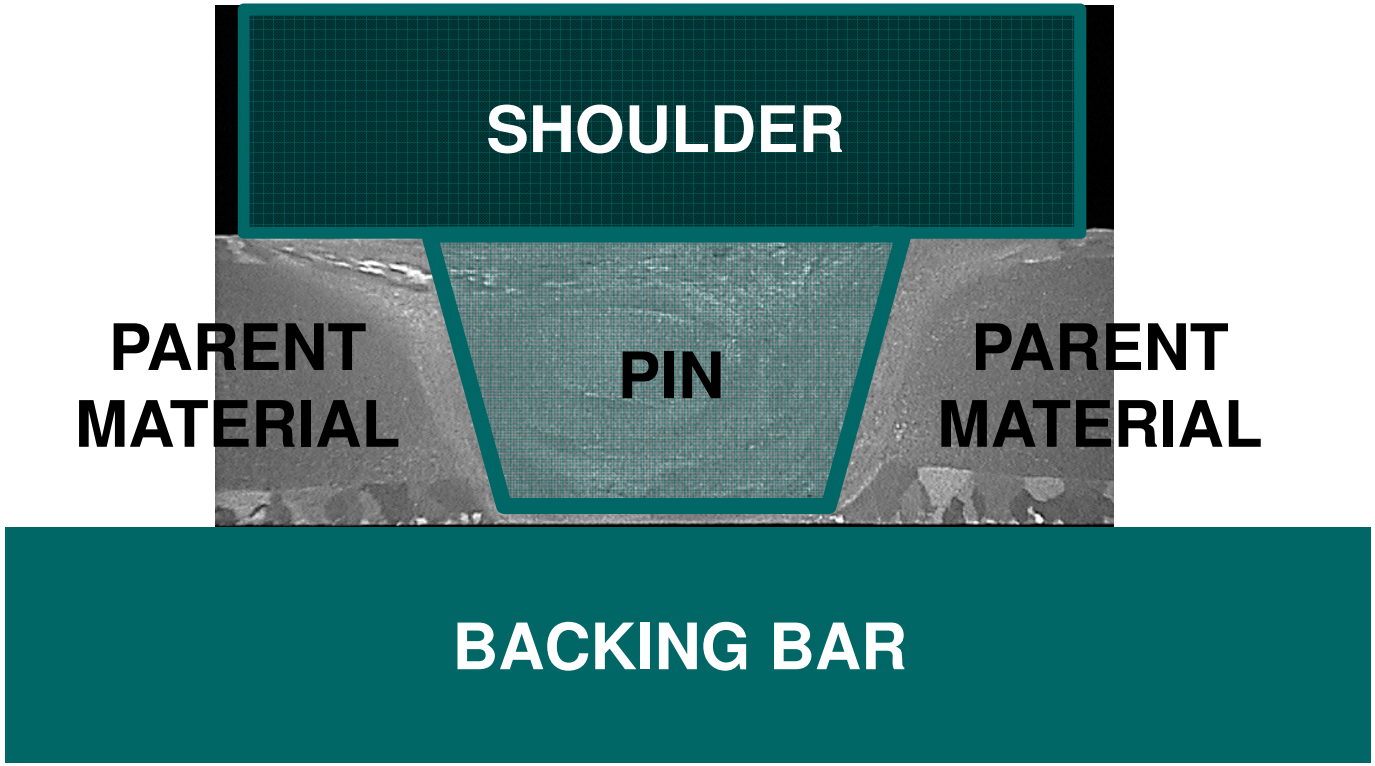


- Strong backing
- High demand of fixation (tolerances, handling)
- Rigid machine
- Solid state process
- No Melting

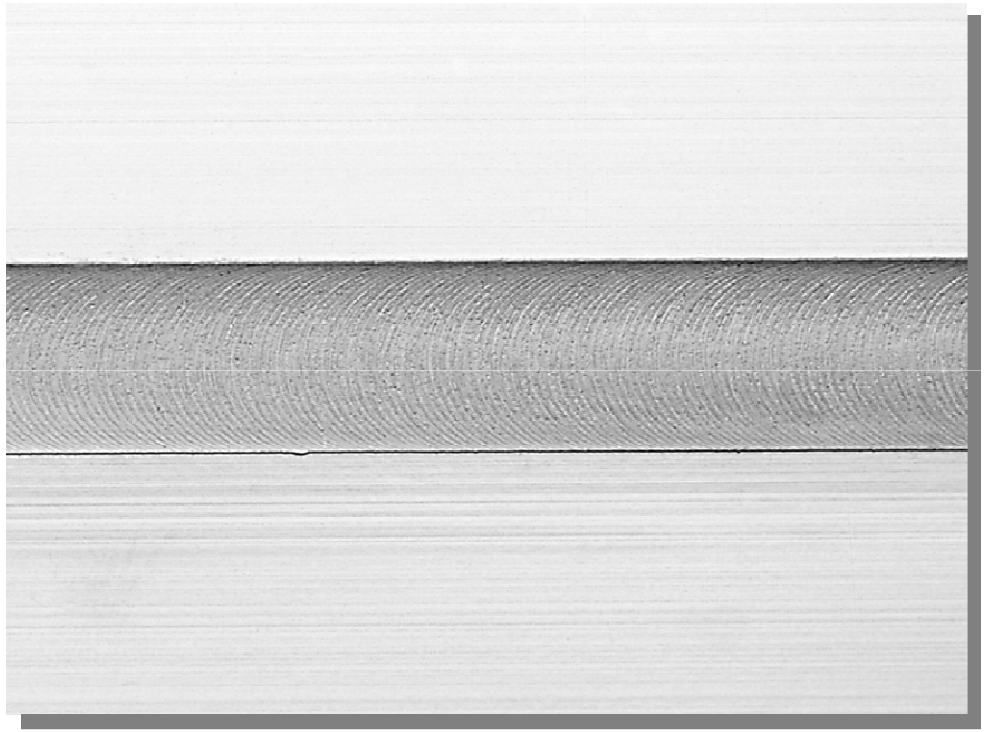
1	Workpiece
2	Tool
3	Probe
4	Tool shoulder
5	Start rotation
6	Touchdown and commence travel
7	Advancing side of weld
8	Retreating side of weld
9	Trailing edge of tool shoulder
10	Leading edge of tool shoulder
11	Exit hole
12	Finnish
13	Withdraw, stop rotation

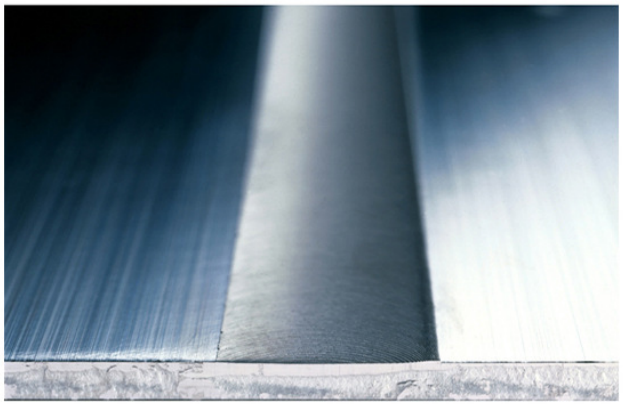
Need to contain the softened material

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

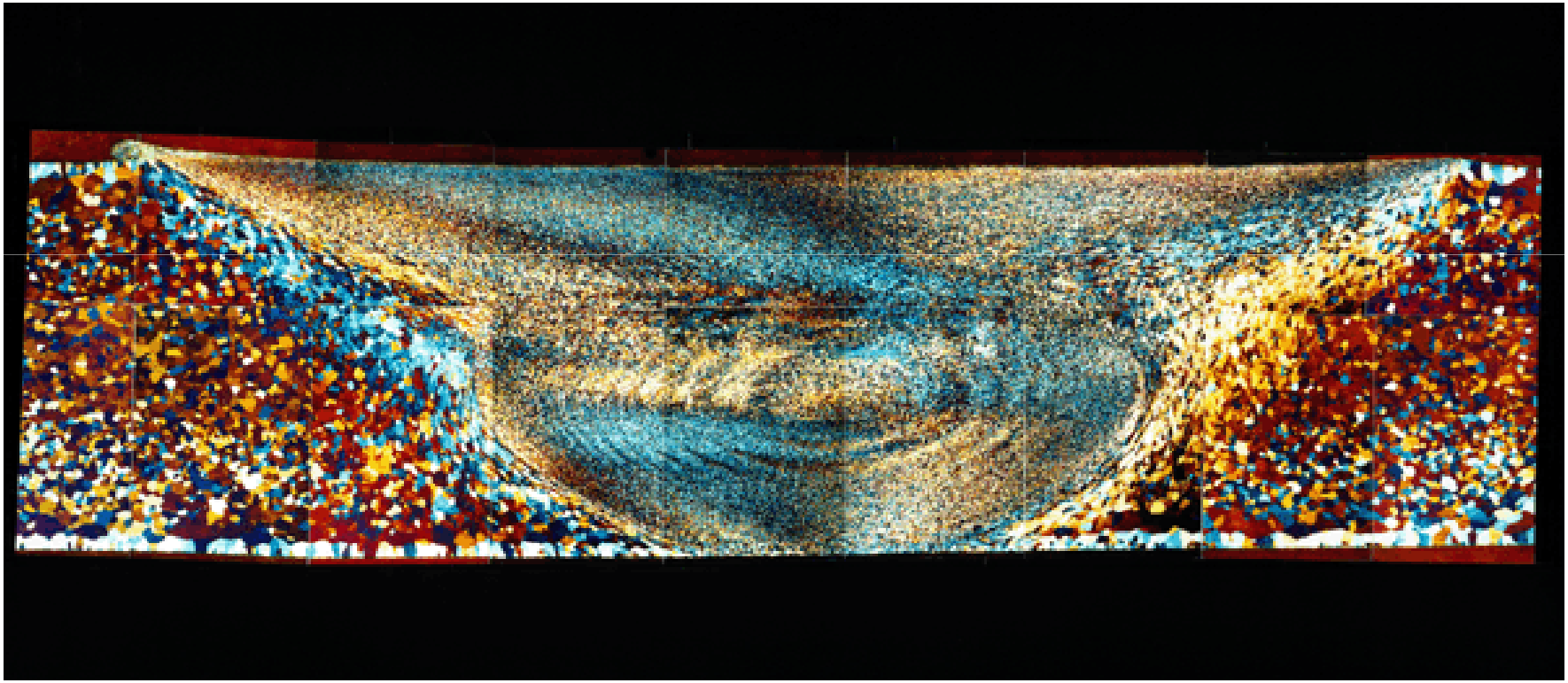


Typical top face of the weld

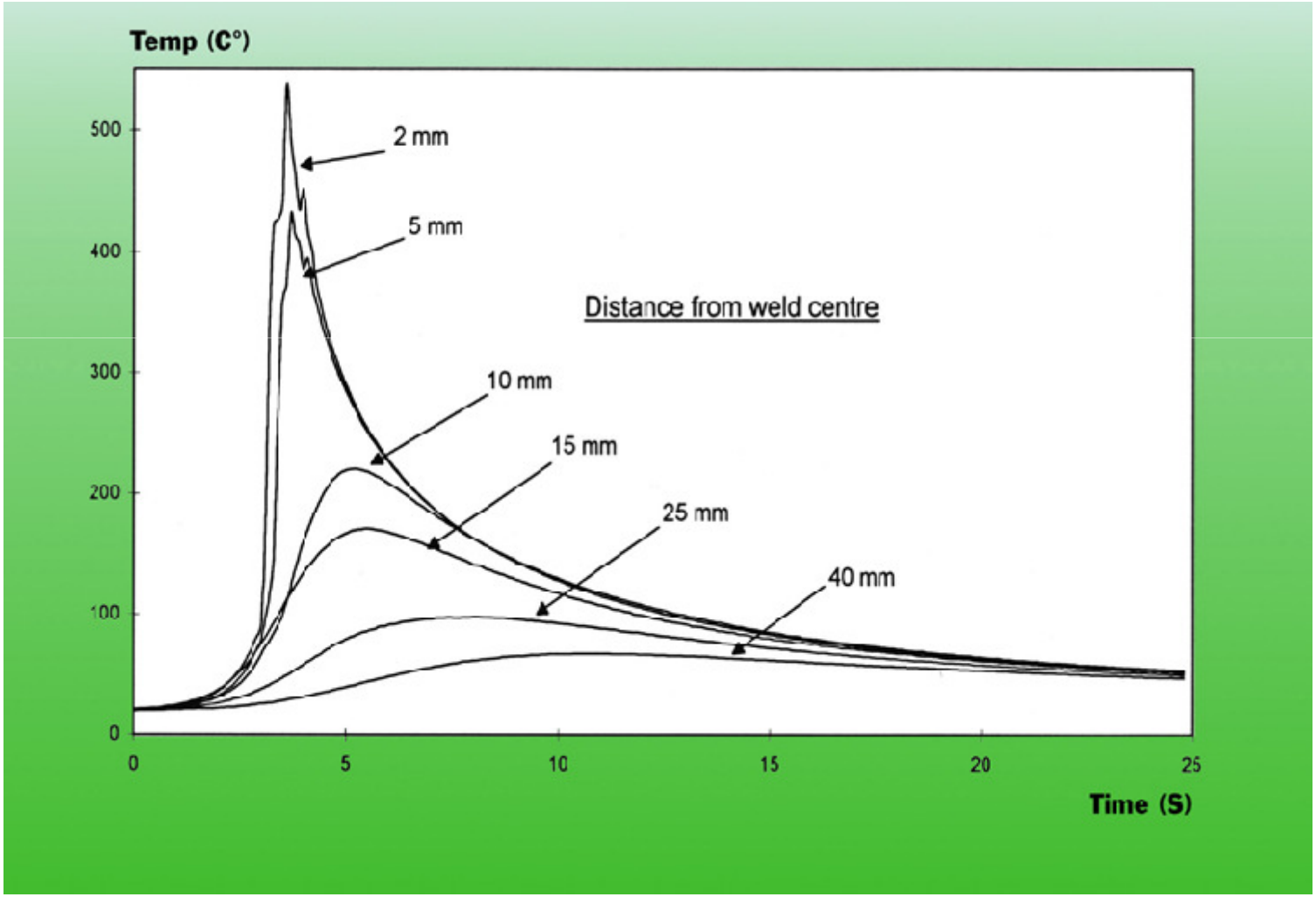




FSW –Weld Structure

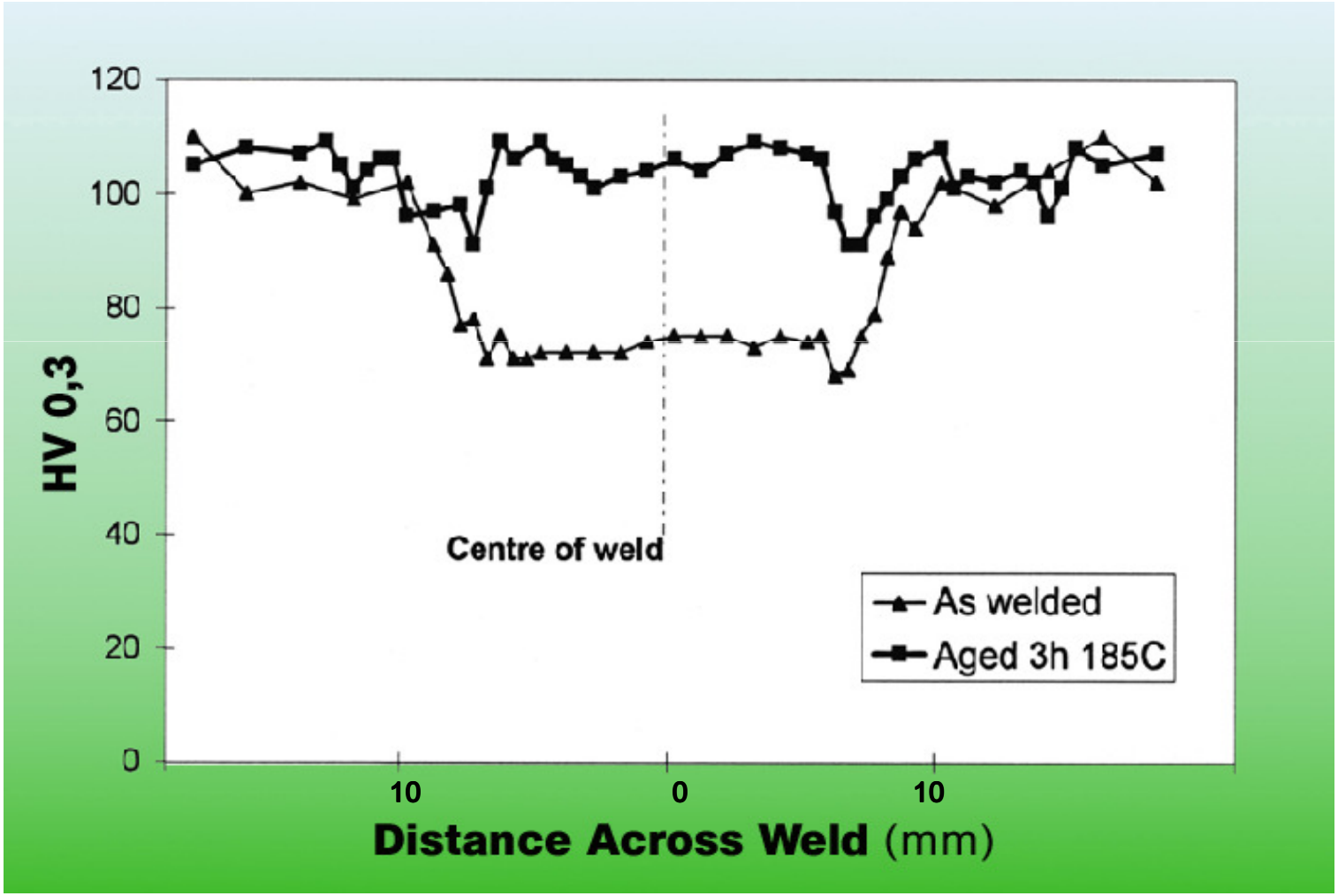


FSW – Temperature Cycle During Welding



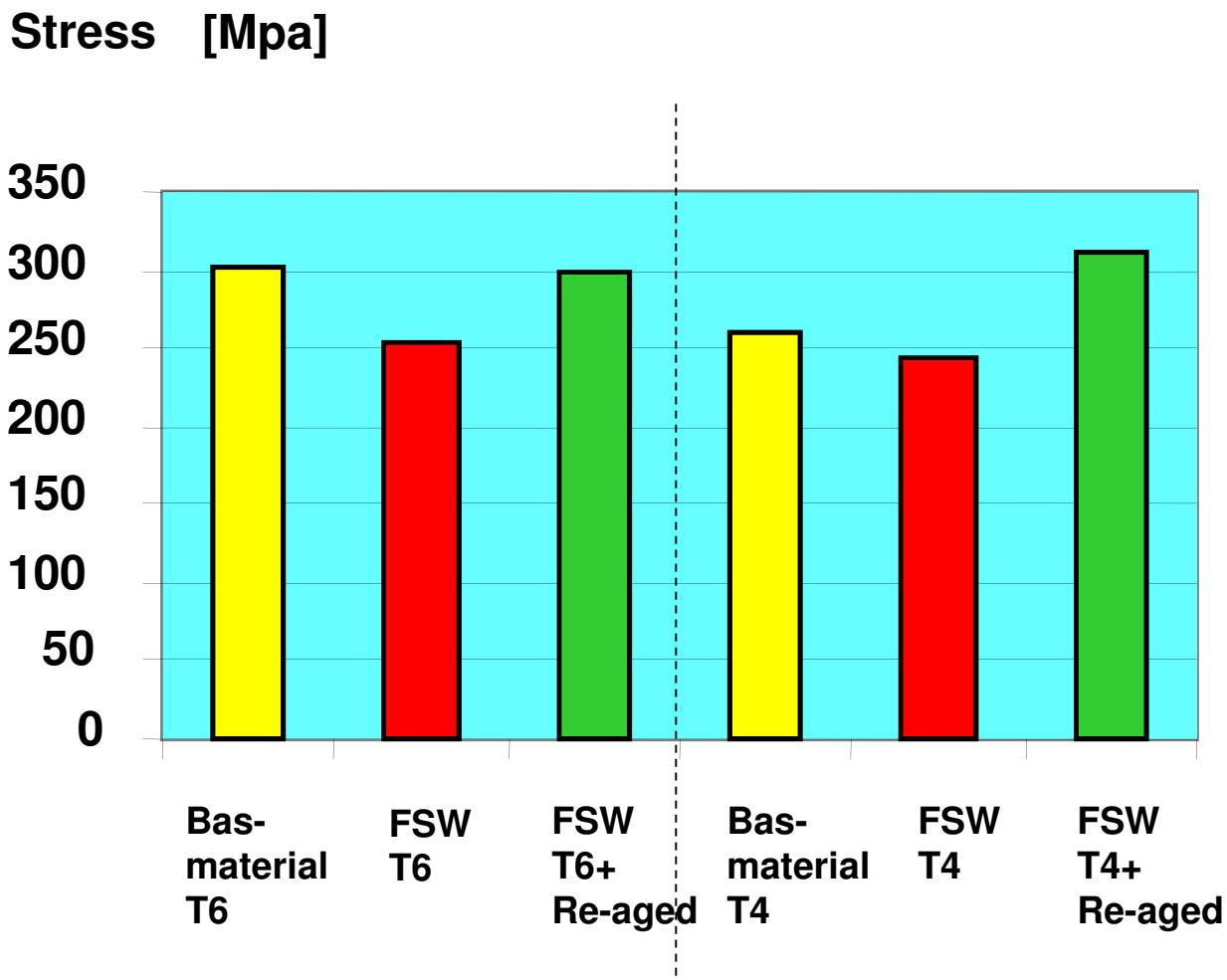
EN-AW 6063-T6 (Material thickness 4 mm)

FSW –Hardness Profile Across Weld

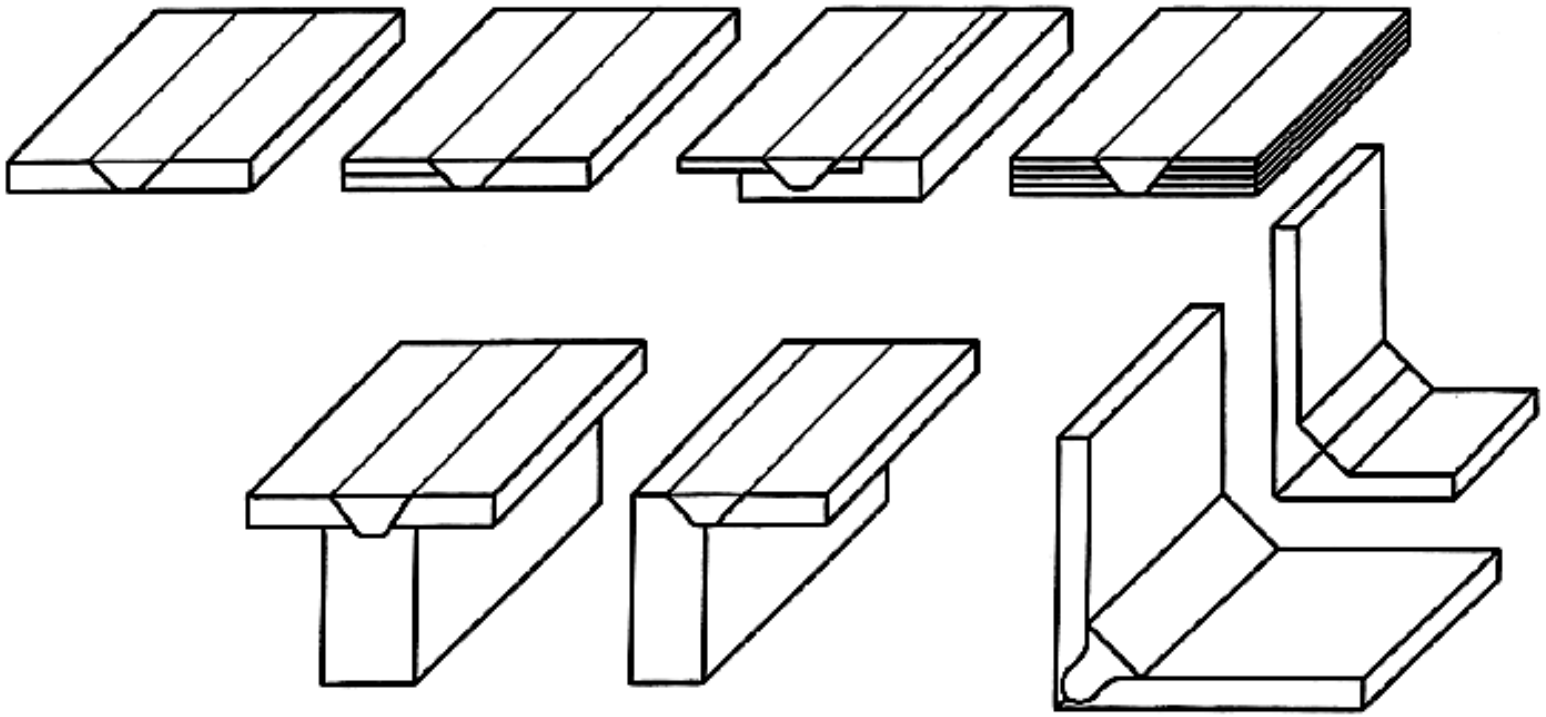


EN-AW 6082-T6

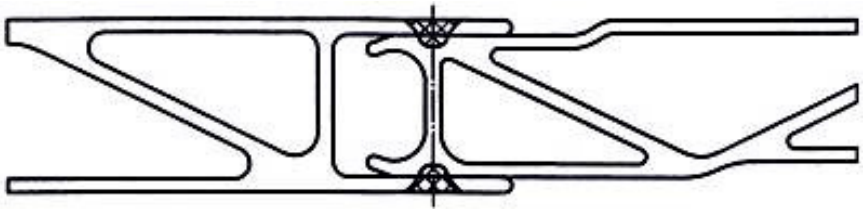
UTS - EN-AW 6082
Different combinations of welding and ageing

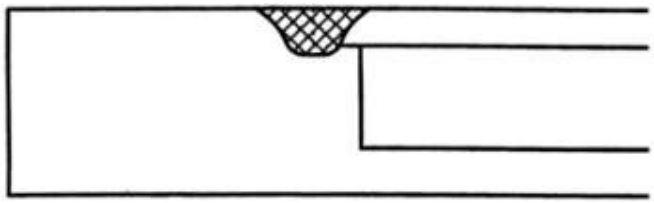


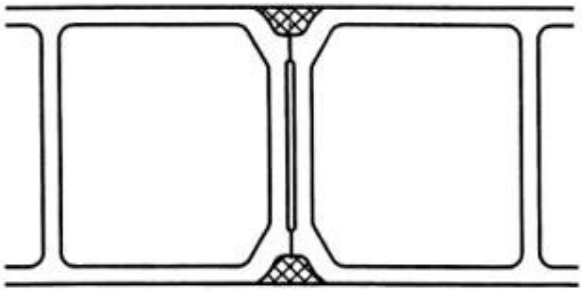
Typical FSW Joint Geometries



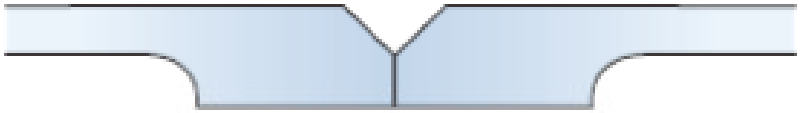
Typical FSW Joint Geometries



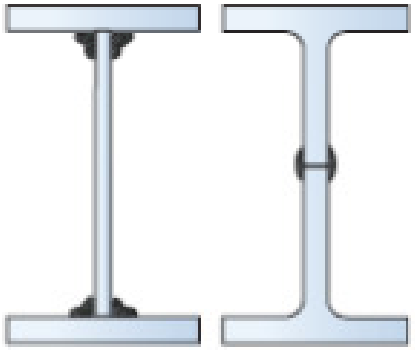




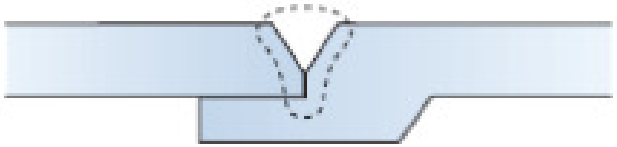
Design The Profile



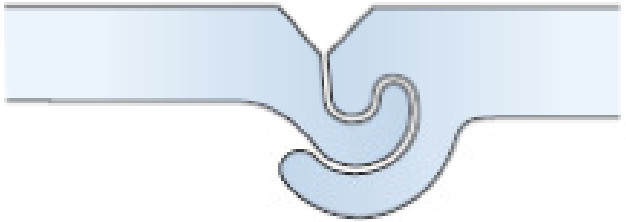
Edge preparation integrated into profile design – the illustration also features material compensation for strength reduction in the weld zone.



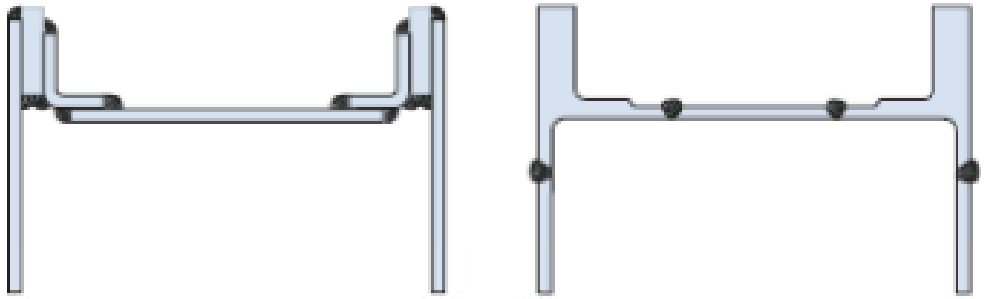
Placing of welds in lower stress sections of the cross sectional area. This results in fewer welds, and butt rather than fillet welds.



Permanent root backing.

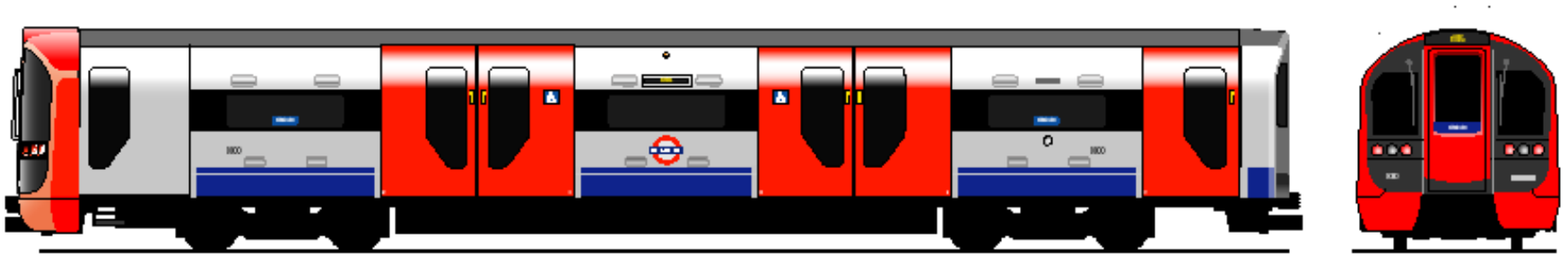


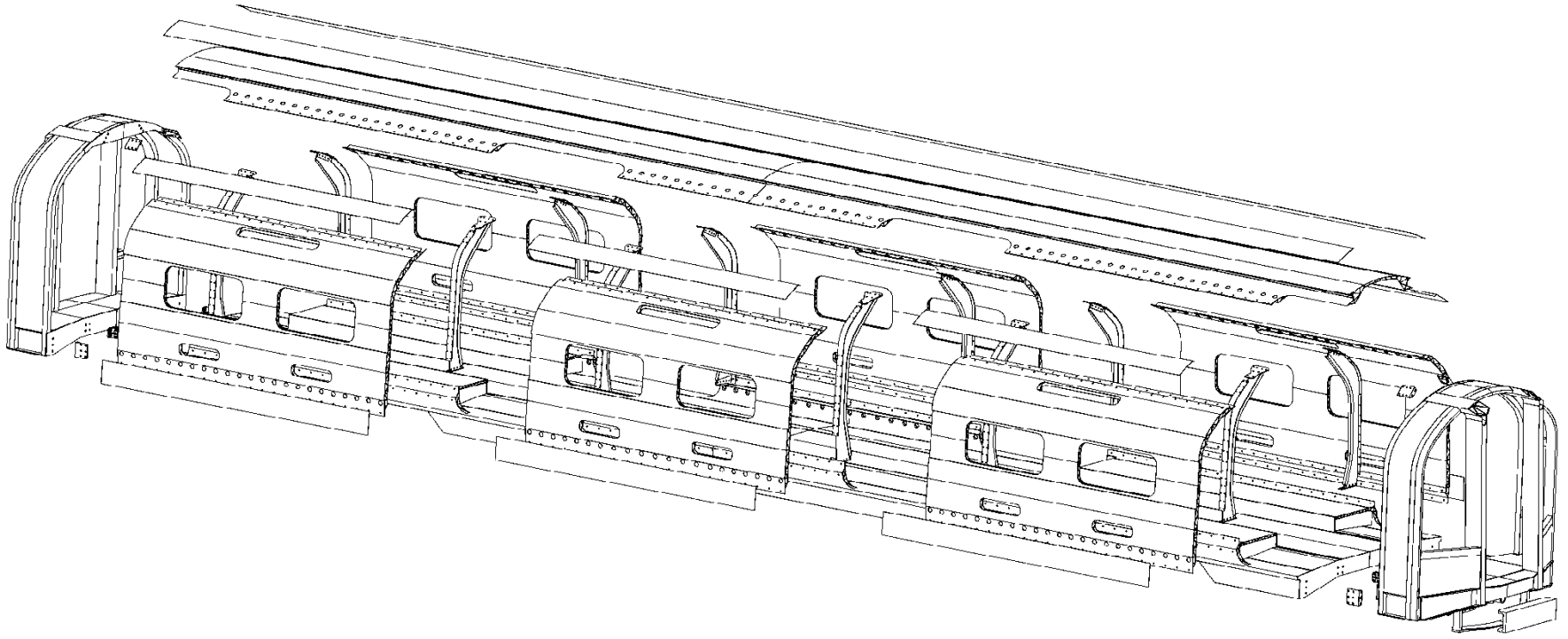
In-built fastening – used in dry environments.



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.

Bombardier ”VLU”





Transit Car Assemblies

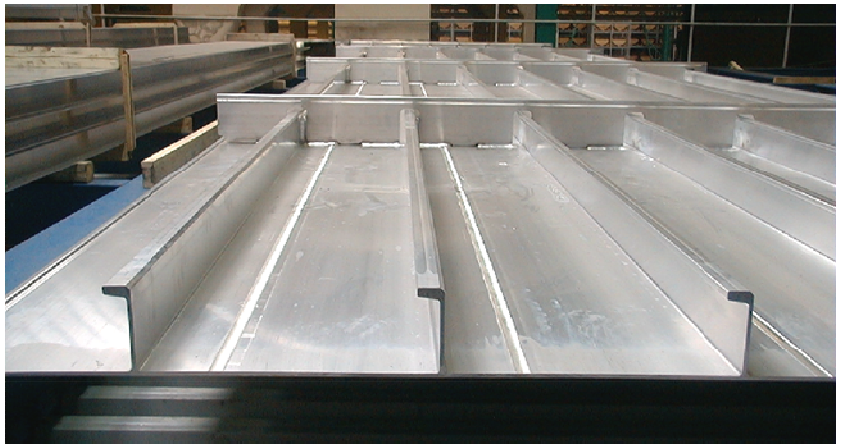
Alstom LHB GmbH

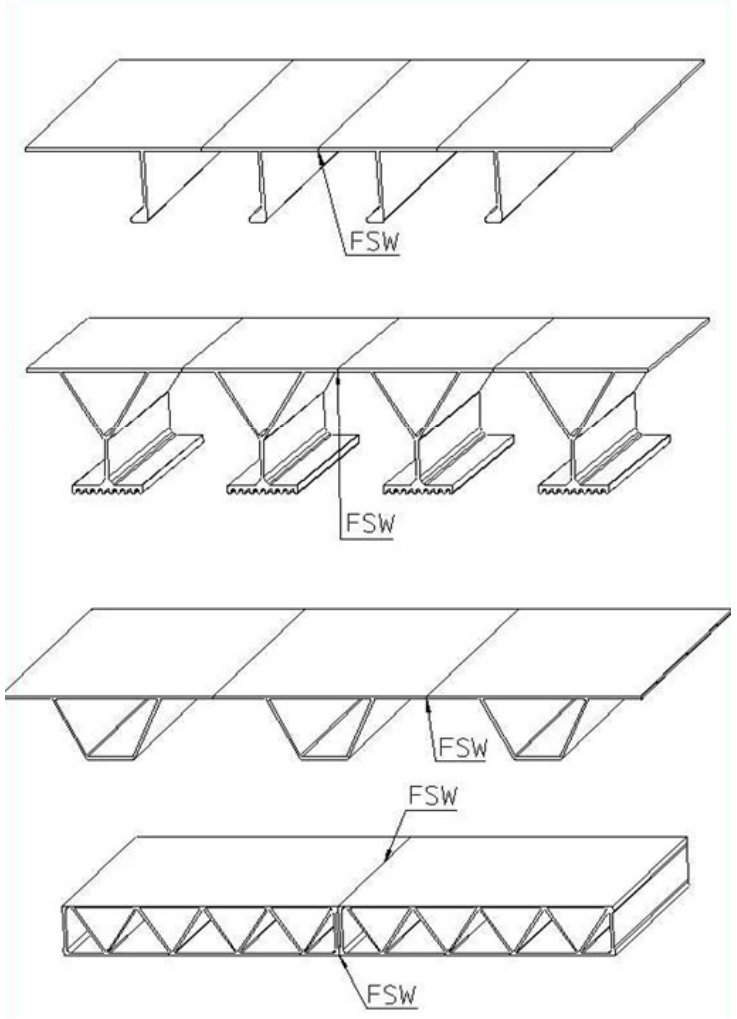
Marine Applications

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

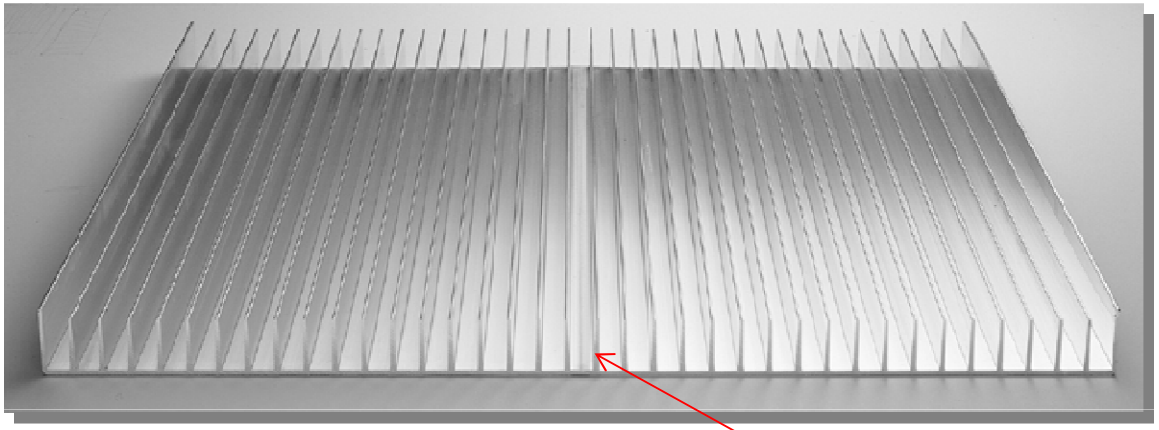
- Mega yachts
- Cruise ships
- High speed ferries
- Military vessels

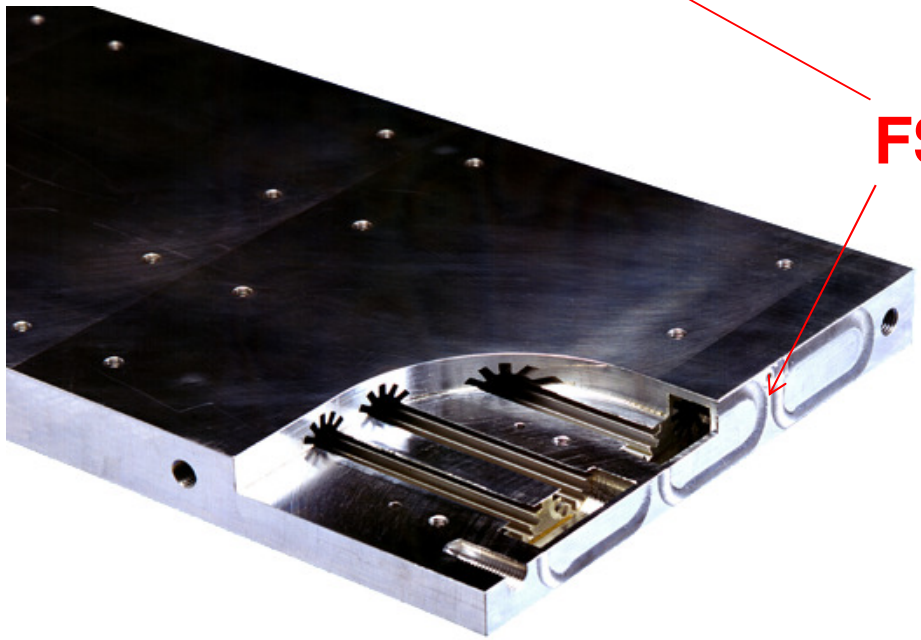
Marine Applications - Examples





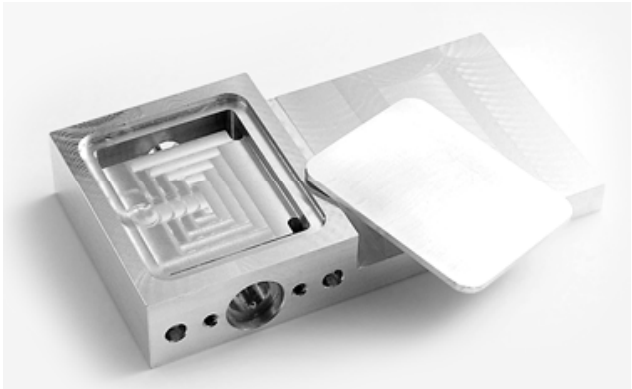
Telecom Applications - Heat Sinks

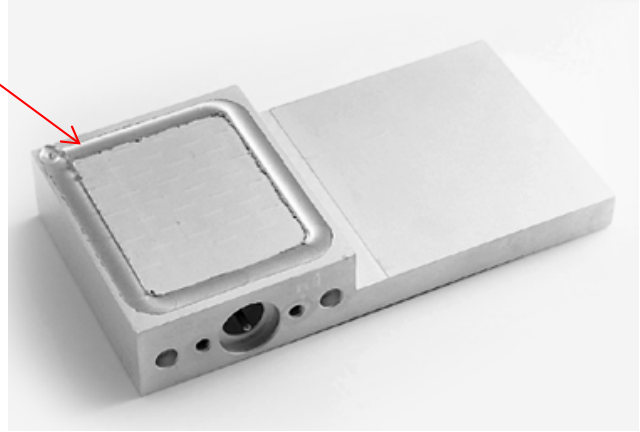




FSW

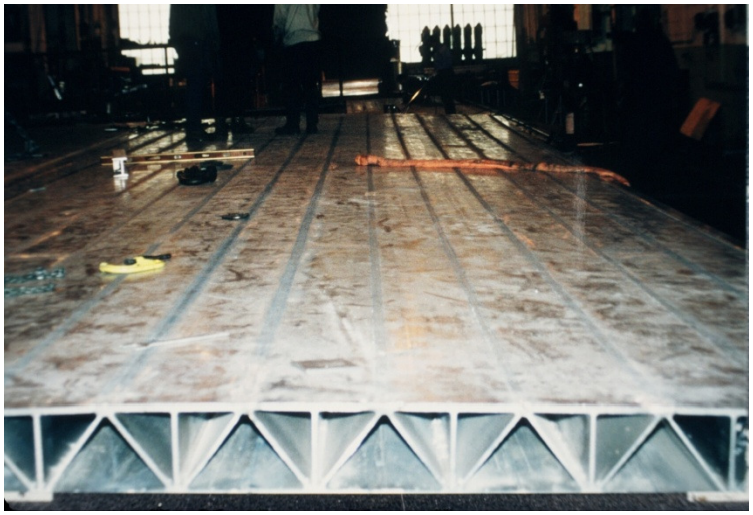
Liquid cooler:
body and lid before and after FSW





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

FSW Information

- Place to find further information: http://www.eaa.net/eaa/education/talat/
- Sapa:s Design Manual, Chapter 10.
- 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?

Shaping the future

For More Information – Contact Randy Thomure
Email: randy.thomure@sapagroup.com

Sapa is environmentally conscious with regenerative equipment and reduced solvent and waste components. Sapa products meet or exceed AAMA specifications.