

FSW-possibilities in Shipbuilding

by : KARI LAHTI,

ESAB AB Automation, Gothenburg, Sweden

Aluminium is increasingly being recognised as an alternative, weight-saving construction material in shipbuilding. Friction Stir Welding expands the scope of application of this material by providing accurate welded components that require minimal fit-up work, and by allowing the use of high strength aluminium grades that were formerly regarded as un-weldable. ESAB LEGIO™ modular friction stir welding machines bring this new welding process within reach at moderate investment costs. Here we discuss the main benefits of friction stir welded aluminium components in ship structures.



Figure : 1. Friction stir welded, straight panels under inspection at ESAB FSW Center of Excellence in Sweden

Assembly work has never been easier

Imagine if a large catamaran could be constructed from building blocks, just like a toy boat. All pieces would fit perfectly to each other and dimensional accuracy and changes could be mastered to full degree. Friction Stir Welding takes the first step towards such assembly work in shipbuilding. Due to the low heat-input during joining and resulting very low residual

stresses, the welded components are accurate and minimal fit-up work is needed. The resulting savings in both time and money are obvious. Since this creates competitive advantage to the users of FSW pre-fabricates, documented information of actual savings is not very often reported. However, Midling et. al. 2000, gives an idea of the possibilities gained by friction stir welded pre-fabricated panels from a panel producers point of view:

- Industrial production with a high degree of completion.
- Extended level of repeatability ensuring uniform level of performance, quality and narrow tolerances.
- The flexible production equipment and capacity allows customer built solutions with reliability of delivery.
- The completed panel units are inspected and approved at present by classification authorities such as DNV, RINA and Germanischer Lloyds.
- The high level of straightness of the panels ensure easy assembly at yard, which means less manual welding.
- Supplementary work for the customer, such as less need for floor levelling and preparation for floor coverings also is a major cost saving with FSW panels.

What is gained after the welding?

One of the most attractive features of friction stir welded products is that they are ready-to-use. No time consuming post-weld treatment such as grinding,

GOUGING TORCHES

metal arc™

M Series



MAT Series



GT Series



Special Features:

- ✓ For high conductivity of current, special grade copper/ copper alloy is used end to end.
- ✓ Heat resistant insulators (for longer life of the torch)
- ✓ Triple air nozzles swivel head (for better metal removal rate)
- ✓ High tension lever allowing firm grip of the electrode (prevents arcing)
- ✓ Insulated dual purpose mono cable for compressed air and electrical current.
- ✓ 360° free revolving movement between torch and mono cable resulting in less wrist stress for welder and better fatigue free working. (Other than GT Series)

Models:

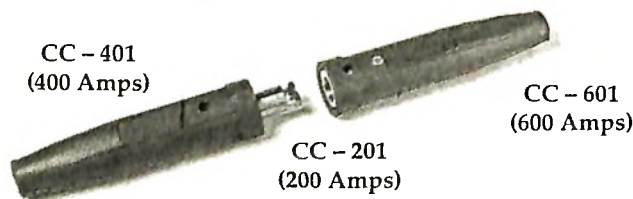
1. M-I (600 Amps)	2. M-II (1200 Amps)	3. M-III (2200 Amps)	4. M-801 (800 Amps)	5. M-1001 (1000 Amps)	6. DSH-22 (2200 Amps)
7. MAT-6 (600 Amps)	8. MAT-12 (1200 Amps)	9. MAT-18 (1800 Amps)	10. GT-601 (600 Amps)	11. GT-1001 (1000 Amps)	12. GT-1801 (1800 Amps)

metal arc™ Gouging Torch are used to Gouge, Chamfer, Groove, Cut, Bevel, Flush off all metals including Aluminum, Copper, Brass, Magnesium, Alloys, Steel, Stainless Steel, Cast Iron and is used by major foundries, shipyards, penstock/ pipe and all structural fabricators, chemical & petroleum complexes.

Process Description: The process involves:

- The striking of an ARC between the metal work piece and the carbon electrode.
- Melting by the ARC, and
- Removal of the molten metal with compressed air jets, flowing parallel to the electrode from the torch.

CABLE CONNECTORS

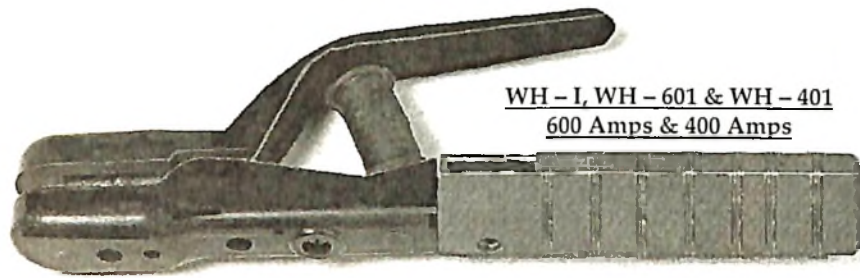


Special Features:

- ✓ Heavy duty cable connector suitable for high capacity usage and efficient operation to perform at nominal voltage drop and at high duty cycles.
- ✓ Interlocking parts made of high conductivity brass machined for close tolerance and perfect fit.
- ✓ Tension adjustments made easily on the split male plug with a screw driver (CC - 601), and Clip type male plug (CC - 401 & CC - 201)
- ✓ The male and female ends of the connector have quick locking arrangement for positive engage/ disengage by 180° twist.
- ✓ Better and quick cable connection at each end by allen screws.
- ✓ Fully insulated with special heat resistant covers for safe operation under normal working conditions.

WELDING HOLDERS

metal arc™



WH - I, WH - 601 & WH - 401
600 Amps & 400 Amps



WH-631
& WH-431



WH-632
& WH-432

- 100% fully insulated.
- For heavy duty manual arc welding.
- Light weight and easy to handle.
- Open mouth jaw type.
- For current rating up to 600 Amps.
- High quality & optimum life.
- Suitable for up to 8 mm electrode dia.



WH - 641



WH - 402

Special Features:

- ✓ Main body is made out of one piece brass alloy (except WHS Series) resulting in better current transmission, special design features ensure low heat and long life.
- ✓ Hood covers and handle are made out of special heat and arc resistant compounds to protect the welding holder from arc damage.
- ✓ For quick connection/ disconnection of cable/ holder handle can be removed by one recessed screw/ snap pin.
- ✓ For better cable connection 3 allen screws provided with D shape grip plate or nut type cable connection.

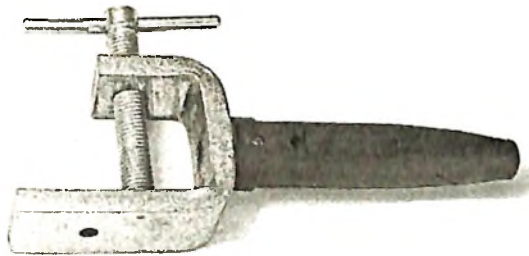


WHS - 661

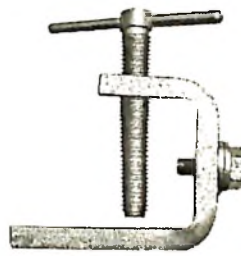
WHS - 662

WHS Series are Semi Insulated

EARTH CLAMPS



EC - 601 (600 Amps)



EC - 602 (600 Amps)



EC - 401 (400 Amps)

Special Features:

- ✓ For current rating up to 600 Amps/ 400 Amps/ 200 Amps.
- ✓ Robust construction from M.S. Section duly plated for longer life.
- ✓ Manual clamping effected through a screw ensuring full contact.
- ✓ 400 & 200 Amps clamping with sturdy spring, and copper braided wire connecting both the jaws for effective conductivity.

Also Available in 1200 AMPS



EC - 201 (200 Amps)

Other Products:

1. **Welding Holder Cable Assembly** - The product includes a welding holder with clip type male cable connector and you can chose from 6 meters to 2 meters of cable. In 11 models of 600 Amps and 400 Amps with **Fully Insulated** OR Semi Insulated Welding Holders.
2. **Earth Cable Assembly** - The product includes an earth clamp with clip type male cable connector and you can chose from 6 meters to 2 meters of cable. In 4 models of 600, 400 OR 200 Amps.
3. **Chipping Hammer** - For chipping & removal of slag & welding spat from the work piece.

Manufactured and Marketed by:

B. R. Kumar & Sons

State Bank of India Building, 2nd Floor, Chandni Chowk, Delhi 110006 INDIA

Phone: 011 - 23868044 & 45

Fax: 011 - 23866471 Mobile: 011 3200 6956

URL: <http://www.metalarc.biz> E - mail: hometex@ndb.vsnl.net.in; sales@metalarc.biz

Contact us for Authorized Agents near you.

Dealership Inquiry Solicited

polishing or straightening is needed. With proper design the elements are ready-to-use directly after welding. However, it is important to keep in mind that designs which are made for MIG or TIG welding, are not necessarily suitable for friction stir welding. The limiting factor often being the relatively high down-force needed when friction stir welding. A proper support in a form of backing bar or design change are often needed (Figure 2). Once done, repeatability reaches levels previously not experienced in welding.

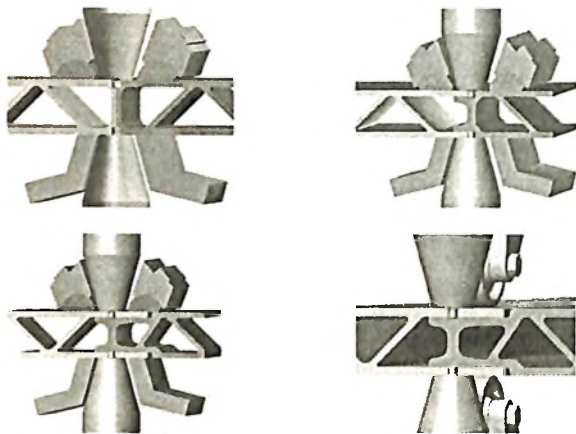


Figure-2: Designs suitable for friction stir welding of 2-skin profiles in aluminium. Illustration: ESAB

When producing large surfaces like walls or floors, besides the straightness of the panels, also the resulting reflections are an important and expensive issue to consider. A lot of time is spent polishing and “making-up” surfaces which are architecturally visible. In FSW prefabricated panels, the reflections are merely caused by the surface appearance of the aluminium plates and profiles in the as-delivered state, not by the reflections caused by welding heat input.

Why use aluminium instead of steel?

One excuse of not using aluminium has always been “that it is not as strong as steel” True -and not true. It, of course, depends also on the alloy to be used, and surprisingly enough, there are aluminium alloys which are as strong or even stronger than steels. For example the so called “ALUSTAR” has yield and tensile strengths comparable to low-alloyed steel S235. AlCu4SiMg (AA2014) - an alloy typically used in aerospace applications -has significantly higher strength than alloys in 5xxx- and 6xxx series which are typically used in ship-building. Some of these alloys just have

not been used in shipbuilding before, due to their poor weldability!

With friction stir welding, some of these barriers can be overcome - just imagine, for example, using strong alloy AA 7021 for making aluminium floor panels even thinner, and gain weight savings by “thinking differently”. In Figure 3 the weldability of various aluminium alloys is shown as a reminder. The typical alloys used in shipbuilding are from 5xxx - series due to their good corrosion resistance, or from 6xxx -series due to the strength. A dissimilar combination between these two alloys is of course also possible (Larsson et. al. 2000).

An easy way to make small-scale pre-fabricated panels or components

Figure 4 gives an idea of relatively easy implementation of FSW in shipbuilding. ESAB’s new LEGIO™ concept is ideal for fabrication of small batches of friction stir welded panels. The equipment is placed on the workshop right next to the assembly of the shiphull. The picture is from Estaleiros Navais do Mondego S.A. Shipyard in Portugal. Even small batches can effectively be welded on-site.

The LEGIO™ concept represents a modular, modern design available for friction stir welding. A series of standardised welding machines puts FSW at every one’s reach. Welds with highest quality are produced even in small batches. Table 1 summarises the range of machines available in the LEGIO™ system. A size “3” should cover the needs of most shipyards.

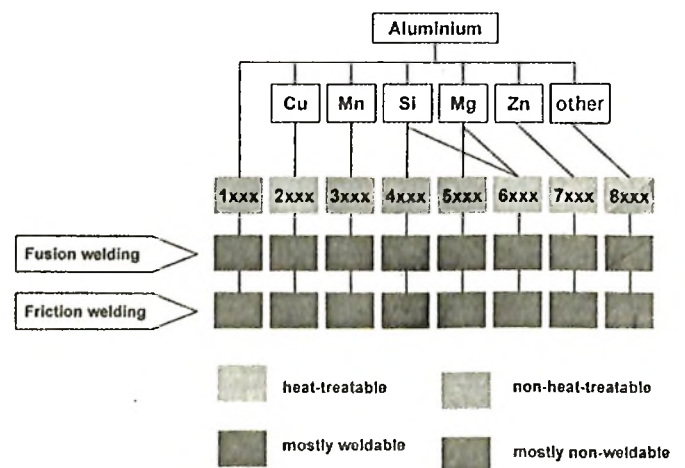


Figure : 3. Weldability of different aluminium alloys.TWI.



Figure - 4: FSW LEGIO™ 3UT installed next to shiphull production line at Estaleiros Navais do Mondego S.A. Shipyard in Portugal

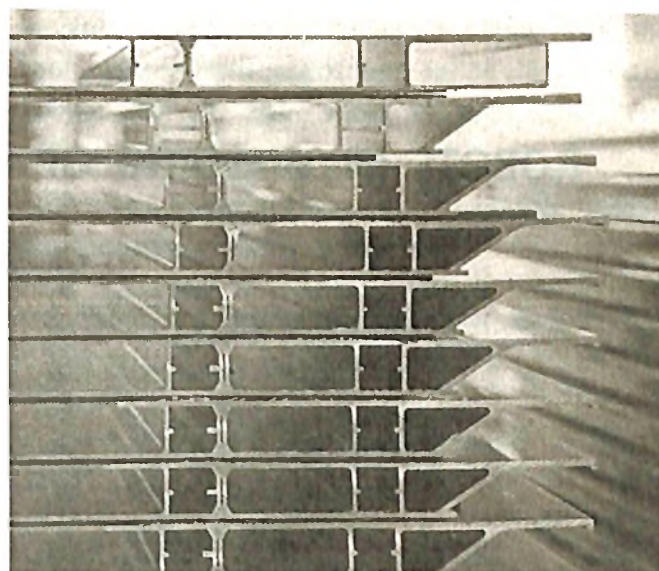


Figure-5: Hat profiles stacked for shipping. Definitely no straightening needed after the welding process.
Photo : Hydro Aluminium

Size	Vertical downforce	Spindle effect	AA 6000	AA 5000	AA 2000 AA 7000	CU (oxygen free)
FSW 1	6 KN	3 kW	3 mm	2 mm	1.5 mm	0.8 mm
FSW 2	12.5 KN	5.5 kW	5 mm	3.5 mm	2.5 mm	1.5 mm
FSW 3	25 KN	11 kW	10 mm	7 mm	5 mm	3 mm
FSW 4	60 KN	18 kW	18 mm	10 mm	9 mm	7 mm
FSW 5	100 KN	22 kW	35 mm	20 mm	18 mm	12 mm
FSW 6	150 KN	45 kW	60 mm	40 mm	35 mm	25 mm
FSW 7	200 KN	90 kW	100 mm	75 mm	70 mm	40 mm

Table-1: The family picture of the new modular LEGIO™ family for easy implementation of friction stir welding.

How to proceed?

Friction Stir Welding is much easier to implement than most other welding processes. The welding operator does not need any special skills, since the parameters are repeatable and high quality is easily achieved time after time. You don't need to be big and powerful to invest in Friction Stir Welding -the modular way. It may, however, make You big and powerful by shortening cycle times and improving the quality of Your products. Just dare to do it!

References:

- Larsson H., Karlsson L., Svensson L-E, 2000. Friction Stir Welding of AA5083 and AA6082 Aluminium. In: Svetsaren 2(2000). 5 pp.
- Midling O.T., Kvåle, J.S. 1999. Industrialisation of the friction stir welding technology in panels production for the maritime sector. In: The 1st International Symposium on Friction Stir Welding. Thousand Oaks, CA, USA 14-16 June. 7 PP.

