AG 52 FSW Processing

2014-09-28
D-no 2030/2014

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Report and minutes No 11

from the meeting **22-23 September** 2013 at Aalto University, Espoo Finland.

Attendance

Matts Björk, SKB, Sweden
Jeroen deBacker, University West, Sweden
Antti Forsström, Aalto University, Finland
Hannu Hänninen, Aalto University, Finland
Juha Kauppila, Finnish Welding Society, Finland
Mathias Lundin, Swedish Welding Commission, Sweden (secr)
Tero Purhonen, Posiva OY, Finland
Timo Salonen, Posiva OY, Finland
Pedro Vilaça, Aalto University, Finland
Ana Silva, University West, Sweden
Anders Westfeldt, Esab AB

Minutes from the meeting 23 September, 8 to 12.30 am

1. Opening of the meeting

In the absence of the chair Mathias Lundin bid everyone welcome and started the meeting. He forwarded the apologies from the chair Lars Cederqvist and also thanked Pedro and Aalto University for last night excellent arrangement of sauna and dinner.

2. Approval of the agenda

The agenda was amended with some more presentations and approved.

3. Minutes (nr 10) of the last meeting 2013-11-05/06 at University West, Trollhättan

The minutes where checked and approved without changes.

4. Short presentation of the organization and activities of new participants

A short round of presentation was made noting the following for new participants.

Antti Forsström started in the beginning of this year as a PhD-student at Aalto University. He is a master in material engineering and will work with the FSW projects.

Ana Silva is a PhD-student at University West where she will take over from Jeroen with the work in the FSW projects. She has a master in material engineering from Porto, Portugal, and worked with FSW in Porto and in Germany.

5. Presentations

5.1 Milestones in Posivas FSW development, Tero Purhonen

Tero gave a presentation on the history and status of the work at Posiva with the storage of nuclear waste and the FSW process (**Appendix 1**).

Tero reported that Finland, since the last meeting, made a choice on the method for the sealing of the canisters for the nuclear waste storage. FSW will be the process and the production will be starting in year 2022.

Posiva has an agreement with Swedish SKB to use the knowledge and cooperate for further development.

Tero noted that EBW also fulfills the requirements for the sealing, however FSW has shown better safety margins.

Tero showed a timetable (Gantt). Preliminary design of the welding system is started with a US company BTI, Bond Technologies Inc. (former MTI).

Noted that Sweden do not have a government decision on the starting of the production.

Both Sweden and Finland have laws not to import or export nuclear waste.

Tero presented the project headlines for the next two years cooperation with SKB.

Tero presented question for the future. Where to find suitable operators in Finland? How to improve Finnish knowledge concerning FSW and support universities. Lack of specified standards. Etc.

Discussed the situation on standards for FSW. There is a difference between copper and aluminium and the forming of imperfections. However, the absence of standards (international specifications) for the performance of FSW is not critical. Noted, though, that there are no standards for FSW equipment as for arc, laser and electron beam welding.

5.2 Status of future FSW center at SKB´s Canister Laboratory, Matts Björck, SKB

Matts presented the attempt to start a research center for FSW processing at SKB in Oskarshamn (**Appendix 2**).

The background is that Östhammar and Oskarshamn municipalities agreed that the one that lost the decision on where the end storage of nuclear waste would be located would receive developing money for the region as an “added value program” containing 1,5 billion SEK over a number of years.

One part of this is an application to the added value program to create a research center for FSW Processing situated in the SKBs Canister lab.

The result of the questionnaire that the Swedish Welding Commission sent out was mentioned.

Probably there will be a setup of a separate organization for the research center, but it will be located within SKB plant.

The Canister Factory will be situated in Oskarshamn and the canisters will be shipped to Östhammar (Forsmark) for the storage.

5.3 Development of parameters for FSW of AZ31 Mg alloy with analysis of mechanical and corrosion properties, Pedro Vilaça, Aalto University

Pedro gave a presentation on the results of a study on the weldability of magnesium thin sheets and comparison with other materials (**Appendix 3**).

The weldability for magnesium with arc welding is very low, however the castability is very good.

The application used was car seats.

Pedro presented the material specification and the experimental conditions and tool configuration.

Factorial trials were performed, based on the Taguchi method, to establish a lobe for the welding parameters, probe rpm, travel speed and applied force.

The mechanism for defect formation in cold and hot welding conditions was analyzed respectively.

Pedro also presented test result from static testing (tensile and bend), fatigue testing and corrosion testing.

5.4 Friction Stir Welding Assisted by Electrical Joule Effect to Overcome Lack of Penetration in Aluminium Alloys, Pedro Vilaça, Aalto University

Pedro further presented tests results with a tool using an external heat source to avoid root defect formation (**Appendix 4**).

He began with giving an overview of possible imperfections in conventional FSW.

The objective with the study was to use an external electrical induced heat source to aid in the process for less formation of root defects, etc.

Pedro presented local heat input models. He further presented the experimental setup to monitoring the parameters for the external heat source.

He presented the tool configuration with a conductive inner shaft

Pedro showed results of good effect on the avoidance of root defect formation for copper. However, it has less effect on steel and magnesium, which have low heat conductivity compared to copper and aluminum.

Pedro concluded that this approach probably have little industrial use.

5.5 Summary of research projects at University West, Jeroen deBacker, University West

Jeroen presented a summary and status of the FSW activities at University West (**Appendix 5**)

The project ARoStir (Increased Automation of Robotic FSW) is a 2 year project that ends in December 2014.

Jeroen presented a compilation of his research on the robot application and the experimental platform at the site in Trollhättan.. The much interesting software was developed through the research.

He addressed the problem to do temperature measuring in the small tools used in robotic welding of aluminium. The approach was to use the electromagnetic gradient in the material combination of steel (tool) and aluminium (parent material) called TWT.

Jeroen showed an example of an "adaptive control" where the parameters are adjusted along with the change in the heat distribution in the parent material due to change in dimensions.

He further showed results of experiments on AA-2060-T6 (lithium) using TWT, were 80 % of the strength of the parent material was reached in the weld. This is very good when noting the usual requirement is 50 %. Discussed the absence of the usual drop in hardness in the HAZ, however this can be related to the Vickers probe size.

Upcoming issues: Using the TWT controller for new FSW variants (stationary shoulder) and for dissimilar materials. Also study the effect of different materials for the backing bars. Also study corner welds with stationary shoulder where 6-axis robot is a must (limitations in the 5-axis).

Jeroen noted that ISO 25239-4 does not address testing methods for lap joints.

Jeroen ended by reporting that he is now moving to a job at TWI in Sheffield to work with robotic FSW. The research at UW will be continued by Ana Silva.

5.6 Application in Aerospace, Anders Westfeldt, Esab

Anders reported, in short, about Esabs project with Boeing and Nasa (**Appendix 6**).

Esab was awarded a big order from Boeing and Nasa for FSW equipment to produce fuel tanks for the next SLS system (Space Launch System).

Nasa had a "ribbon cutting ceremony" going public with the project some month ago.

The rocket fuel tank is approx. 55 m in length, and the welding machine is 60 m high and 25 m in diameter.

The welding is performed horizontal of circular section with a bobbin tool.

Anders expressed his hope to get back to the group in more detail, but in the meantime he referred to information published by Nasa on the internet (search for Nasa and SLS).

6. IIW 68th Annual Assembly & International Conference, 28 June to 3 July 2015 Helsinki, Finland.

6.1 General presentation, Juha Kauppila, The Welding Society of Finland

Due to a bus strike in Helsinki Mr Kauppila could not attend.

The 68th IIW Annual Assembly and International Conference will be held in Helsinki, Finland from June 28th to July 3rd, 2015

Timo showed circular no 1 available at www.iiw2015.com

It was noted that the dean of the School of Engineering at Aalto University, Gary Marquis, is the current president of IIW.

6.2 Preparation of activities/contributions for Commission III, IIW 2015. E.g. CIII-B special session on “Applications of FSW in shipbuilding industry”

Pedro informed that the new chair of Commission III, Dr. Jorge F. dos Santos, is planning a full day (1 July 2015) a seminar on the "Application of FSW in Shipbuilding".

It was noted that next year is the 20 year anniversary of the first industrial application of FSW, in Norway (Marine Aluminium).

It was noted that students pay only 1/3 of the fee.

The best presentations made in all working units are accepted for publication in Welding in the world.

7. Messages and Reports – conferences, articles etc

Upcoming events besides IIW Annual Assembly:

TMS Conference will be held in March 2015 in the US. Lars Cederqvist is going. It is too late to submit papers.

Nordic Welding Conference is held 5-6 November in Tampere, in connection with the Nordic Welding Expo. There will be a couple of presentations on FSW at the conference. See www.nordicweldingexpo.fi. See attached program (**Appendix 7**).

Jeroen told about FSW symposium, 20-22 May 2014, Beijing, China. See http://www.fswsymposium.co.uk/. He noted less news than before. TWI is however planning to continue with the symposium. Next one in Cambridge in May 2016.

The federation of Finnish Technology Industries' Aluminum products branch group has its Aluminium day in Turku the first day and Stockholm the second day.

8. Licence and patent issues

Mathias noted the following current status which the members concurred:

- Un-featured tools are possible to use without violating the patent since December 2012

- Featured tools are possible to use without violating the patent from,
  - January 2015 in Europe
  - September 2015 in US

Noted that this should induce an increase in the use by smaller companies.

It was noted that this is a perfect opportunity to spread the word on the possibilities for smaller companies to use FSW in larger scale.

Pedro will, on the invitation of the Finnish welding magazine, will write an article on FSW. This article could be reprinted in the other Nordic welding magazines. Discussed that this could be complemented with an article, maybe from Esab, on examples of application, simple and more complex. Two articles that could be translated for the first issues of the Nordic welding magazines.

Anders will ask internally is he or someone (e.g. Mikael Soron) could compose such an article, by the end of the year at the latest.

9. Short report on FSW standardisation activities in IIW

Mathias presented the status of the standardisation projects on FSW in IIW (**Appendix 8**). Project leading has changed to David Bolser from Boeing.

ISO/CD 18785-1 to -5 Friction stir spot welding – Lap welds in Aluminium, for which the launch date of the technical enquiry is unclear.
ISO 25239-1 to -5 Friction stir welding – Aluminium, was published in 2011.

As a member of Swedish Welding Commission one has access to the documents produced by C-III.

10. Information projects – Inventory

Postponed.

11. Working Program and member issues (prospective participants etc)

Postponed.

12. Arrangement for subsequent meeting(s)

The next meeting was decided for 26-27 May 2015 at Posiva in Olkiluoto.

13. Closure of the meeting (13.30 h)

In the absence of the chairman the secretary thanked everyone for their attendance and contribution, and Prof Pedro Vilaça for the splendid hospitality we enjoyed.

Meeting secretary

Mathias Lundin