FSW-Tech

Friction Stir Welding European Qualifications

Hands-on Approach Seminar SLOVAKIA

17th September 2019

VÚZ – Slovakia

Project Nr: ***2017-1-SK01-KA202-035415***

This project has been funded with support from the European Commission. This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein

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Introduction

This report focuses on the assessment of the results, the lessons learned at the National Hands-on Approach Seminar (E5) held in Slovakia. This report and evaluation was carried out in accordance with the agreed criteria for the assessment of the selected factors by the project partners.

In Slovakia, the national seminar for held for the level of the EFSW Operator. The assessment was carried out with a focus on all the teaching materials developed for this level (presentations, textbook)

The objectives of this evaluation are:

- to detect the main strengths and weaknesses of the training materials;
- to summaries suggestions based on the results of the questionnaires for adjusting and improving the curriculum and study materials according to the feedback received in E5.

1. Methodology

Venue and participants

In Slovakia, we focused on evaluating the teaching materials and the teaching process for the Operator level. The training was held for two days, the first one on 16.09. 2019 in the premises of the Welding Research Institute, focused on practical demonstrations of FSW technology welding in the workshops and the theoretical part was performed on 17.09.2019 during the conference "National Welding Days 2019" in Demänovská Dolina. The whole process of theoretical and practical training was attended by 6 participants.

Training Program

The training was divided into two parts: the theoretical part and the practical part.

The **theoretical part** – held on 17.09.2019 in six 45-minutes training hours and was focused on the presentation materials CU1-CU6. Training materials as the exercise book and the presentations developed during the project for the level EFSW Operator were presented.

At these meetings, the fundamentals of the FSW welding process were presented, highlighting the different stages of the process and the underlying factors that influence this welding technology. The impact of this process on the mechanical properties of various materials and some activities that may affect the final quality of the joint were also discussed. The theoretical part presents case studies of the practical implementation of the FSW process into the production process in practice. The presentations highlighted the benefits of using FSW welding technology over other welding technologies and the possibility of replacing other welding technologies that are commonly used in current practice with FSW technology.

FSW-welded specimens were also shown to the participants, and the most common errors that may occur when using this welding technology were shown on the specimens. Presentations were made in Slovak language.

Figure 1-1: Theoretical session in Slovakia

The **practical part** was held for six 45-minute hours and on 16.09.2019 and focused mainly on the following topics:

– Practical demonstration of FSW welding of different materials and different positions of materials to be joined. & Preparation and selection of tools and equipment for welding and definition of individual welding parameters; & Preparation of welding materials; & Check the weld during and after welding.

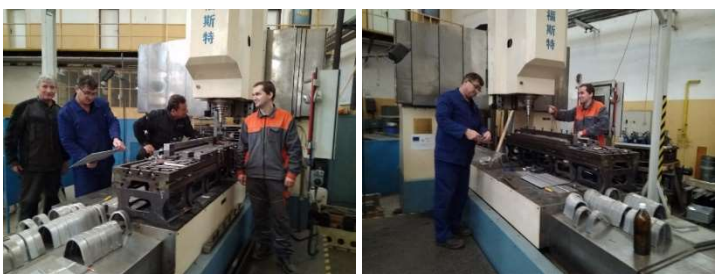
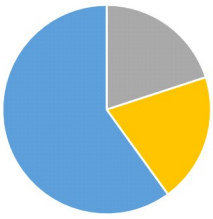
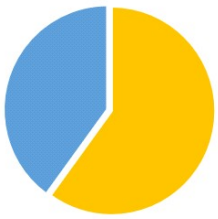


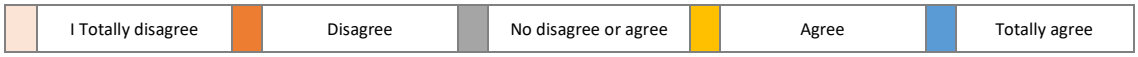
Figure 1-2: Practical Session in Slovakia

Date	Contents
09:00 – 09:30	Registration
09:30 – 10:30	CU1 – FSW Fundamentals CU2 – Joint Preparation and Definition
10:30 – 11:00	Break
11:00 – 12:00	CU3 – FSW Process Operation CU4 – Post Processing
12:00 – 13:00	Lunch
13:00 – 14:00	CU5 – Health and Safety CU6 – Maintenance
14:00 – 14:30	CU1 – CU2
14:30 – 15:00	Break
15:00 – 15:30	CU3 – CU4
15:30 – 16:00	CU5 – CU6
16:00 – 17:00	Report preparation about changes need to the training materials

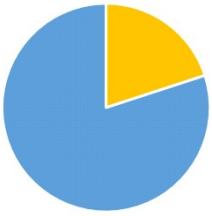
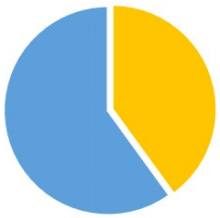
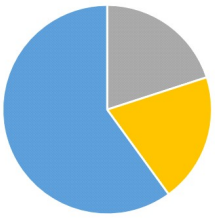
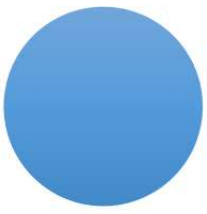
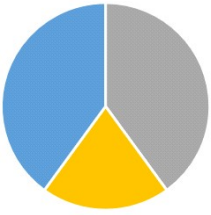
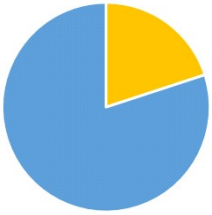
Evaluation

Participants received E5 questionnaires in electronic form to evaluate the entire Hand-on-approach seminar and the training materials used. As there were only 6 participants and only 5 participants were involved in evaluation, the evaluation may not be objective. These results are graphed and are as follows:

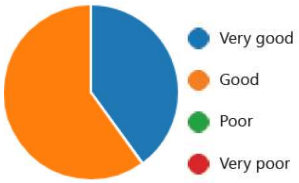
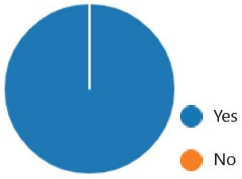
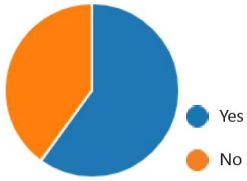
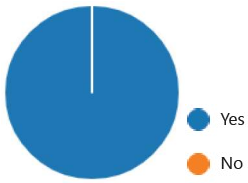
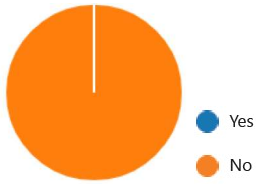
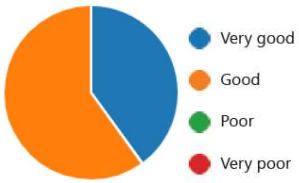
Information and training provided were clear and easy to follow	The presented information met my expectations	The presented information was well organised
		
Allocated time for the topics discussions was appropriate	**I had the opportunity to adress questions**	**The training Enhanced my understanding on the subject**
		



The presenter/trainer …

Adressed my needs of information	Gave opportunity and encouraged questions	Offered clear and detailed answers to the questions
		
Communication style kept me focussed and interested	**Provided practical examples to illustrate the point**	**Provided clear explanation on each topic discussed**
		
Resolved my issue(s) or question(s) about the seminar	**Applyed adequate training techniques**	**Overall how would you rate the seminar?**
		

Training Materials Evaluation

How do you rate the sequence and flow of the slides presented	Was there a clear separation between the seminars's units?	Did the presentation included adequate number of dynamic resources/elements (e.g. video, exercises, practical examples)
		
Was the quality of the content consistent throughout the seminar?	Did you notice any unnecessary repetitions in the content?	Did you feel that some content was lacking?
		
How do you classify the overall quality of the supporting materials (slides presentation) used in the seminar?	Please highlight 2 positive aspects about the training materials	Please remark 2 aspects for improving the training materials
	"Presentations have been created very clearly and the facts that can be used in practice have been presented. Textbooks are handled in an understandable form" "Sufficient range of training materials Appropriate processing of topics as regards the scope of each topic. " "Well chosen textbook textbook and presentation format The great advantage of the training was that VUZ has a device on which were also performed practical demonstrations of welding with FSW technology " "Simplicity - Listed Basic Facts Good clarity " "The training materials for the operator were of sufficient scale and quality It was very good that we had practical snaps of FSW welding on the VUZ equipment "	"More images from practice More real-life examples " "Graphic edit More real samples - welded joints of different materials by this technology " Include more information in the course materials on the possibility of obtaining other training and in-service literature. Individual topics should be complemented by practical examples Real examples and samples of joining various materials

2. National recommendations for implementation

The Welding Research Institute (VUZ) has many years of experience in teaching the welding personnel of different skill levels and welding technologies and has a large number of highly skilled trainers and welding experts. Therefore, we emphasize the importance of the pedagogical basis of the entire training and vocational technical training, which can be very important for the level of students' acquired education.

Recommendations for improvement:

- Trainers must not only be proficient but also have presentation experience and skills;
- Presentations must contain more images, video demos, less text, only facts;
- Interactive involvement of students in the education process during lectures, actively seeking information on the Internet, etc.;
- Complementing the presentation with online interactive tools such as games / quizzes aimed at increasing attention and engaging students in the learning process.
- Special attention should be paid to technical and practical training, especially for the level of the Operator;
- The exposure method (directive, deductive and demonstration) was mainly used in this seminar. We advise teachers of practice to apply research methods (induction, research, reflex, problem solving, inquiry, etc.) to keep students interested.

A very important factor of the whole training process is the lecturer, who must possess not only technological knowledge but also pedagogical skills and methodological knowledge for the proper management of students so that they are able to fully absorb the learning issue.

Visiting workshops and practical demonstrations, especially for the qualification level of the Operator, have proven to be a very important step in the process of consolidating the acquired knowledge, giving students the opportunity to see the real course of all welding activities, but also equipment used in the FSW process as well as various samples, defects, which allows discussion of the possible causes of such defects.

3. Conclusions

The overall evaluation of the seminar was very positive. But it is necessary to take into account the number of participants of the Slovak seminar, in which only 6 participants participated. In drawing up the final report, we will also draw on the results of the other project partners.

As with other harmonized EWF studies, this study should have a system of continuous monitoring and quality monitoring to continuously improve the learning process.

An important outcome of the survey is the fact that the participants have not made any major reservations about the quality of the technical materials in terms of expertise.

The training materials used were created in the IO3 output of this project and consist mainly of textbooks and “PowerPoint” presentations.

There is still room for improvement, in particular by providing presentations with interactive online tools (games / quizzes / in-house, up-to-date information), which will be incorporated into presentations in order to more involve seminar participants in the learning process.

The main recommendation on this topic is the creation of teaching and presentation materials that should be interactive and would allow them to continuously incorporate new up-to-date information on the technology from science and research, but also from practice.

4. Annexes

CU 1 – FSW Fundamentals				
Objective for Operator: Factual and broad knowledge of: – FSW fundamentals – Welding equipment and processes – Parent materials				
Objective for Specialist: NA				
Objective for Engineer: NA				
Scope	**Qualification** **Teaching hours**	**Engineer** **NA**	**Specialist** **NA**	**Operator** **0,5 h**
Introduction to FSW FSW equipment FSW Design Parent Materials				
Learning Outcomes for Operator : – Identify the main mechanisms of the process – Recognize the main terminology used within FSW – Identify the main advantages and disadvantages of the process – Identify the main applications for FSW – Recognise the machine – Identify the main components of a FSW machine – Identify the limitations of the machine – Identification and assembly of essential components (such as the probe/pin/tool) – Prepare the correct welding tools according to the WPS (position and clamping) – Understands the importance of the cooling system – Follow the maintenance procedures – Recognise the design limitations of the process – Recognise different types of welding probe/pin/tool – Correlate different types of welding probe/pin/tool to the operations/material/thickness – Recognise the limitations of the process for the different materials + thicknesses – (Aluminium, Copper, Magnesium, Steel, Thermoplastics, Titanium, Dissimilar)				
Learning Outcomes for Specialist: NA				
Learning Outcomes for Engineer: NA				

CU 2 – Joint Preparation and Definition

Objective for Operator:

Factual and broad knowledge of:

- Joint preparation
- Welding Procedure Specification

Objective for Specialist: NA

Objective for Engineer: NA

Scope / Qualification / Teaching hours	Engineer	Specialist	Operator
	NA	NA	0,5 h
Cleaning Clamping FSW Parameters Welding Procedure Specification (WPS) Types of joints			

Learning Outcomes for Operator :

- Recognise the importance of cleaning
- Distinguish different cleaning methods
- Identify the consequences of using an unappropriated thickness
- Identify different measuring devices
- Measure the thickness and length of the parts to be welded
- Recognise the importance of using jigs and fixtures
- Understand the importance of the clamping systems
- Understand the importance of choosing the correct program
- Identify the influence of parameters in the weld
- Distinguish between variable and fixed parameters during welding – control system
- Recognise the parameters in the control system
- Interpret the WPS
- Distinguish between different types of pin/probes/tools
- Adjust the pin/probes/tools according to the WPS
- Perform the tool/pin/probe offset (x-y)
- Control the plunge depth
- Adjust the z position (z)

Learning Outcomes for Specialist: NA

Learning Outcomes for Engineer: NA

CU 3 – FSW Process Operation				
Objective for Operator: Factual and broad knowledge of: – Auxiliary Equipment – Most common problems of FSW				
Objective for Specialist: NA				
Objective for Engineer: NA				
Scope	**Qualification** **Teaching hours**	**Engineer** **NA**	**Specialist** **NA**	**Operator** **0,5 h**
Auxiliary equipment Problems of FSW during the process and actions to solve them				
Learning Outcomes for Operator : – Distinguish between different types of auxiliary equipment – Recognise the purpose of each auxiliary equipment – Identify the most-common basic problems that can occur during the process – Take basic actions to solve those problems				
Learning Outcomes for Specialist: NA				
Learning Outcomes for Engineer: NA				

CU 4 – Post Processing				
Objective for Operator: Factual and broad knowledge of: – Post processing – Visual Inspection				
Objective for Specialist: NA				
Objective for Engineer: NA				
Scope	**Qualification** **Teaching hours**	**Engineer** **NA**	**Specialist** **NA**	**Operator** **0,5 h**
Visual Inspection Actions to avoid imperfections/defects				
Learning Outcomes for Operator : – Recognise unclamping precautions – Identify weld imperfections/defect and its causes – Recognise causes and appearance of weld imperfections – Implement preventive and corrective actions for imperfection/defects				
Learning Outcomes for Specialist: NA				
Learning Outcomes for Engineer: NA				

CU 5 – Health and Safety				
Objective for Operator: Factual and broad knowledge of: – Health & Safety				
Objective for Specialist: NA				
Objective for Engineer: NA				
Scope	**Qualification Teaching hours**	**Engineer NA**	**Specialist NA**	**Operator 0,5 h**
Safety Regulations Accidents, their causes & preventive actions				
Learning Outcomes for Operator : – Apply safety regulations and precautions – Identify possible accidents that may occur due to the use of FSW – Associate the accidents and its causes – Implement preventive actions – Recognise the risks (electrical, mechanical, heat and noise) associated to FSW – Recognise the need to apply the H&S measures associated to each risk – List the preventive and protective measures to minimize or reduce the risk – Use the personal protective equipment correctly				
Learning Outcomes for Specialist: NA				
Learning Outcomes for Engineer: NA				

CU 6 – Maintenance				
Objective for Operator: Factual and broad knowledge of: – Proper vs. damaged conditions of back plate, probe, clamping and positioning devices				
Objective for Specialist: NA				
Objective for Engineer: NA				
Scope	**Qualification Teaching hours**	**Engineer NA**	**Specialist NA**	**Operator 0,5 h**
Back plate conditions Tool conditions Clamping/positioning devices conditions				
Learning Outcomes for Operator : – Distinguish when the backplate needs to be changed/replaced or cleaned – Distinguish when the backplate needs to be changed/replaced – Identify when the clamping system needs repair				
Learning Outcomes for Specialist: NA				
Learning Outcomes for Engineer: NA				