

metal JOINing

K-Projekt Network of Excellence for Metal JOINing

Programme: COMET – Competence Centers for Excellent Technologies

Programme line: K-Projects

COMET subproject, duration and type of project:

PS – Electron beam welding of 9-12% Cr-steel (EBW), 09/2014 – 08/2018, strategic

Using a matched interlayer to enhance the hot cracking resistance of a 9% Cr-steel

Content of this project is the investigation of the electron beam weldability of a boron and nitrogen strengthened 9% Cr steel (NPM1). It has been revealed, that independent from the used parameters there is a hot-crack formation within the fusion zone. Based on comparative bead on plate welding with comparable 9% Cr steel (P91/P92) and same parameter configuration, a fitted filler material for the interlayer was determined. Joint weld between the participating 9% Cr steels (NPM1-P91) with different dilution proved the positive effect and the suppression of hot-crack formation with increased amount of P91.



State of the art and definition of task

During the performed bead on plate welding, the boron and nitrogen strengthened 9% Cr steel revealed a serious cracking problem. Scanning electron microscope investigation classified the occurred cracks as hot-cracks. Systematic variation of the parameters improved the results according to accumulated area and length of the hot-cracks. Nevertheless, it was not possible to avoid them completely. New focus to prevent the formation of hot-crack in the fusion zone lied on the selection of a fitted filler material for an interlayer and the optimized dilution.

Definition of the task was to perform comparative bead on plate welding with comparable 9% Cr-steel (P91/P92) to verify the used parameter set and to investigate the suitability as a filter material with respect to suppress hot-crack formation.

Joint weld (NPM1-filler material) with different dilution should detect a critical ratio between

NPM1 and a fitted filler material to ensure sound and crack-free welds for the future.



Comparative bead on plate welding and butt-welded connection

Comparative bead on plate welding for P91 and P92 with the same parameter configuration were performed. While P92 showed a to NPM1 similar hot-cracking behaviour, it was possible to produce completely crack-free and sound P91 welds (see Fig. 1).

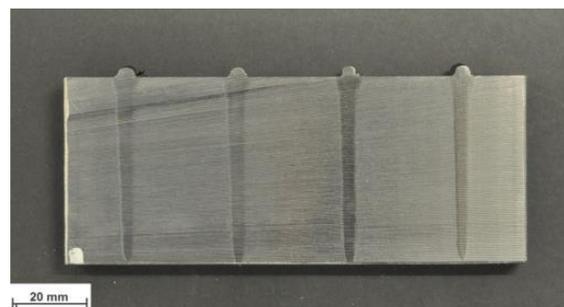


Fig. 1: Comparative bead on plate welding of a P91 to investigate the filler material suitability

In the course of the comparative bead on plate welding the used parameter set has been verified and the suitability of P91 as a filler material has been proven.

Therefore a joint weld between NPM1 and P91 was produced. To get a different dilution depending on the investigated position, the abutting face of the participating had a 1° angle (see Fig. 2).

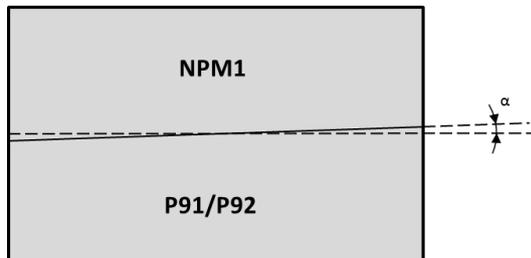


Fig. 2: Schematic figure of a butt-welded connection between a NPM1 and a P91

To investigate the influence of different dilution to the cracking behaviour different locations of the weld seam were observed (see Fig. 3). It has been revealed, that with an increasing amount of P91 there is an improved hot-cracking resistance. A ration of 55% P91 and 45% NPM1 delivered promising results (see Fig. 4).

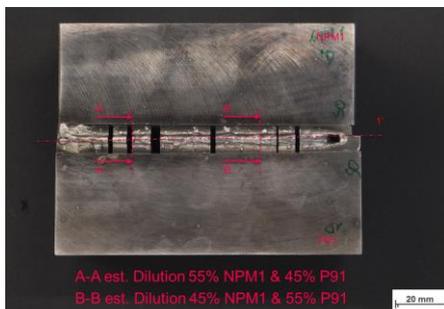


Fig. 3: Joint weld between NPM1 - P91 with different dilution

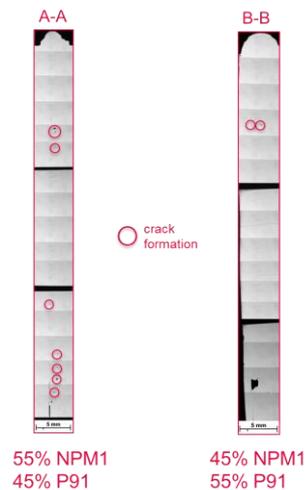


Fig. 4: Cross-sections with different dilution joint weld NPM1 and P91

Impact and effects

Based on the performed investigations the used parameter configuration was verified and a fitted filler material, which will be used as an interlayer, selected. The necessary interlayer thickness was detected due to a joint weld between NPM1 and P91 and it was revealed that at least an amount of 55% P91 is necessary to improve the hot-cracking behaviour in a significant way.

For the future, joint welds with different interlayer thickness (1.5mm / 60%P91, 2mm / 80% P91 und 2.5mm / ~100% P91) will be produced and characterized.

The performed experiments enable a fast selection of a fitted filler material and quantify a minimum interlayer thickness / dilution. These are valuable informations for further investigations. Thereby, a solid base for the solution of the hot-cracking problem of an electron beam welded boron and nitrogen strengthened 9% Cr steel.

Contact and information

K-Project metal JOINing (JOIN)

Institute of Materials Science, Joining and Forming
Kopernikusgasse 24/I, 8010 Graz, Austria
T +43 (0) 316 873-7181
E office@imat.tugraz.at, www.iws.tugraz.at

Project coordinator

Assoc. Prof. Dr. Norbert Enzinger

Project partners

Organisation	Country
IMAT TU Graz	Austria
ISF RWTH Aachen	Germany

Further information on COMET – Competence Centers for Excellent Technologies: www.ffg.at/comet

This success story was provided by the consortium leader/centre management for the purpose of being published on the FFG website. FFG does not take responsibility for the accuracy, completeness and the currentness of the information stated.