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Co-Chairs: Pingsha Dong, University of Michigan; Honggang Dong, Dalian University of Technology; Oksana I. Shpigunova, Tomsk State University

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Effect of heat input on microstructure and formability of DP980 steel welded joints by fiber laser welding

Qian Sun, Northeastern University

ABSTRACT

The welding on DP980 steel with 1-mm thickness was implemented by IPG6000W fiber laser in this present. The microstructure of welded joints was observed by optical metalloscope (OM) and scanning electron microscope (SEM). Micro-hardness tester was used to test the micro-hardness on cross-section of welded joints. Erichsen test was carried out to study the formability of welded joints with the heat input increased, and the fracture morphology was observed by SEM. Based on the experiments, the effect of heat input (12, 18, 24, 30, and 42 J/mm) on microstructure and formability of welded joints was studied. The results showed that the microstructure of welded joints was similar with the heat input increased, consisted of fusion zone (FZ), coarse-grain heat affect zone (CG-HAZ), fine-grain heat affect zone (FG-HAZ), mixed-grain heat affect zone (MG-HAZ), and sub-critically heat affected zone (S-CHAZ). FZ was solidification microstructure with lath martensite. The microstructure of CG-HAZ and FG-HAZ consisted of lath martensite and granular carbide, and the grain size of FG-HAZ was finer. MG-HAZ was constituent of ferrite and lath martensite, and S-CHAZ was ferrite and tempering martensite. The peak hardness was reached at CG-HAZ to be considered as hardening zone. The softening zone was located in MG-HAZ and S-CHAZ, and the softening degree and size was increased with an increased of heat input. The difference of hardness was depended on the corresponding microstructure in each zone. When heat input was 12–24 J/mm, the fracture of Erichsen samples was at base metal (BM). When heat input was 30–42 J/mm, the fracture was in softening zone of HAZ, which indicated that the significant softening degree and size reduced the strength of welded joints and deteriorated the formability. The research work would provide necessary data and theoretical basis for the application of DP980 steel.

KEYWORDS: laser welding, heat input, welded joint, microstructure, micro-hardness, formability