Fatigue of Laser-Arc Hybrid Steel Welded Joints and Comparison with Conventional Arc Welding

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The laser-arc hybrid welding process, which combines laser and arc welding, is gradually coming out of laboratories, but is still not widely used in the industry, in particular in France.

However, the use of hybrid welding in mechanized welding allows productivity improvements such as rising welding speed, reducing pre or post welding operations, reducing the number of welding passes and brings the advantages of laser welding, such as penetration depth.

The ANR HYPROSOUD project proposes a global approach of this process to convince industry of all its potential. A compact equipment adapted to a production environment and fitted on a robot was developed early in the project and was used to set the welding procedure specifications. At the same time, modelling and numerical simulation were performed and over 200 fatigue tests were carried out at the Institut de Soudure in order to compare the fatigue resistance of laser-arc hybrid joints with conventional arc welded joints.

T-joints, butt joint and L-joint from S355 and S700MC grade steels and thickness between 5 and 12 mm were tested under different loading modes. Especially, specimens were subjected to bending or transversal load leading to root cracking.

Both arc welding and laser-arc hybrid welding processes were used to weld the specimens, all of them with single-sided joint in order to meet the welding conditions of the industrial partners. Laser-arc hybrid welding process needs 1 pass when conventional arc welding can need up to 4 passes depending of plate thickness and preparation. Therefore it can be seen some differences in weld geometry. The tests confirm that resistance of assemblies is closely linked to geometry parameters like weld toe radius, and to the depth of penetration in case of load leading to root cracking.

All tests were conducted until 2.10^6 cycles in order to draw S-N curves of laser-arc hybrid welding process, and compare the resistance of this new promising process with IIW recommendations as well as with conventional arc welding.

Laser-arc hybrid welding process brings many advantages for welding assemblies. In addition, its mechanical behaviour is at least very close to conventional arc welding or even better due to its high penetration ratio.

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