C. Process Investigation and Development for Precision Fillet Welding of Lightweight Ship Structures

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New ship designs are calling for complex, lightweight panels made of thinner steel (as thin as 3 mm) for weight and structure optimization. For stiffener welding on ship panels, thin steel demands small, precision fillet welds (as small as 3 mm) in order to reduce panel distortion and improve downstream processes. In this study, four processes were investigated for their ability to make small and large fillet welds in shipyard production.

The existing panel welding systems in most shipyards use flux-cored arc welding (FCAW) with mechanical seam tracking. The process and seam tracking combination did not offer enough robustness and agility for making 3 mm fillet welds in shipyard production.

Tandem gas metal arc welding (T-GMAW) has shown an increase in deposition rate of up to three times that of single electrode. However, when T-GMAW was combined with through-the-arc (TTA) seam tracking by weaving, the travel speed was limited to 1 m/min (40 in/min) and the minimum fillet weld size was 5 mm. Laser seam tracking may be used with T-GMAW; however wire electrode cast will lead to weld placement problems.

Rotating electrode (RE) GMAW utilizes TTA seam tracking by rotating the contact tip and electrode around a small diameter at 10 to 100 Hz. The process has capabilities to seam track while making welds as small as 2 mm at travel speeds as high as 2.5 m/min (100 in/min). However, since RE-GMAW is a single electrode process, it cannot match the deposition rates of T-GMAW.

Rotating lead tandem (RLT) GMAW is a new process that offers deposition rates comparable to T-GMAW with the seam tracking capability of RE-GMAW. Procedures were developed for making 3-8 mm fillet welds with one torch setup. While offering high deposition rates, it also demonstrated high resolution seam tracking at travel speeds up of 2.3 m/min on 3-mm fillets.

Of the processes reviewed in this study, RLT-GMAW offered the highest quality and productivity potential. RLT-GMAW also offered enhanced process robustness when compared to the existing FCAW process, T-GMAW and RE-GMAW.