

HYBRID WELD DEVELOPMENT FOR SHIP STRUCTURAL COMPONENTS

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SUMMARY

This paper describes a Navy Joining Center (NJC) project to examine “hybrid laser welding” for fabrication of ship structural components. This project is funded by the Office of Naval Research (ONR) in cooperation with the National Shipbuilding Research Program (NSRP) as part of the Shipbuilding Initiative (SI). The SI is intended to connect the technology needs of the shipbuilder with Navy MANTECH Centers of Excellence (COEs) to transition new technologies to the industry. The project includes participation from iMAST, Newport News Shipbuilding, Bender Shipbuilding, Ingalls Shipbuilding, NSWC-Carderock, and Edison Welding Institute.

Recent work in Europe and the US demonstrates the advantages of a new welding approach that combines arc and laser welding technology into “hybrid welding”. The hybrid approach provides the deep penetration of a laser with the robustness inherent in the arc welding processes. Additional advantages of the hybrid approach are:

- Lower laser power requirements permit the use of lower-cost commercial equipment;
- The technology can be integrated into existing shipyard welding mechanization to maintain current production;
- The process potentially allows greater control over the bead geometry, which could improve fatigue properties and overall structural life.

While laser welding of ship steels in structural configurations has been demonstrated, requirements for joint fit-up have limited laser applications in shipyards. Also, autogenous laser welds cool too quickly and result in microstructure with unacceptable performance (toughness). Thus, the hybrid laser welding approach is an attractive process.

Development efforts within this project have been directed in hybrid welding ship structural steels DH-36 and HSLA 65 in 0.250" and 0.50" thicknesses. Hybrid weld systems have been created using off the shelf Nd:YAG and CO₂ laser equipment. Standard DC and pulsed welding power supplies and conventional wire chemistries have been used. Weld trials were done on square butt joints with various gaps and joint edge preparations. Full penetration single pass weldments have been produced in 0.25" square butt joints at travel speeds in excess of 40 ipm with joint gaps up to .063". Weld distortion has been minimal in comparison to arc welding processes.

CONCLUSION

This project is comparing hybrid laser welding to conventional arc and laser welding processes for the fabrication of typical ship structures. The work to-date has indicated that the hybrid process is capable of producing weldments with very little joint preparation in comparison to the groove preparation associated with arc welding for the material thicknesses under investigation in this project. The results also indicate that the process is more tolerant to joint fit-up than autogenous laser welding. The ability of hybrid welding to produce quality welds with various gaps provides a robust manufacturing tool for shipyard fabrication. Project activities will continue by examining material properties and performing a cost analysis for implementation.

Upon completion, the project will aid in determining the value of using hybrid laser welding for specific shipyard applications. An implementation plan will be developed to demonstrate that the process can meet US Navy specifications for welded structures using typical shipyard materials. In addition to fabrication of ships, hybrid welding has the potential to impact other DoD platforms where material performance and distortion are issues for fabrication.