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Improvement on the Fatigue Life of Welded Joints by the Synergy Effect of Ultrasonic Impact Treatment and Steel with High Resistance to Fatigue Crack Growth

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Summary: The extension of the fatigue life of welded joints has been in demand to improve the safety and reduce the life cycle cost of ships.To meet such demand, it is effective to apply post-weld treatments which prevent crack initiation from weld toes or new steels which retard crack propagation in base metals. In this paper, the improvement on the fatigue life of welded joints by the synergy effect of ultrasonic impact treatment (UIT) and steel with high resistance to fatigue crack growth (F/M steel) is investigated. F/M steel has a microstructure with elongated and banded martensite phase distributed in a ferrite matrix, thickness of 49 mm, and EH36-class strength and toughness. Fatigue life to failure (Nf) is evaluated by dividing such into fatigue life to crack initiation (Nc) and crack propagation (Np) by means of the 5% strain drop method. As a result, the fatigue life of an out-of-surface gusset welded joint using UIT and F/M steel increases 8.7 times in Nc, 4.3 times in Np and 5.0 times in Nf, respectively, compared to an as-welded joint using conventional steel. The extension of Nc is a result of decreased stress concentration and tensile residual stress near the weld toe due to UIT. The extension of Np can be attributed to the increase of the resistance to fatigue crack growth for enhancing the roughness-induced crack closure of F/M steel with the decrease of the tensile residual stress due to UIT. Evidently, the synergy effect of UIT and F/M steel can significantly improve the fatigue life of welded joints.

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