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Fatigue strength of TIG-dressed ultra-high-strength steel fillet weld joints at high stress ratio

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Abstract

The effect of stress ratio on the fatigue strength of TIG-dressed fillet weld joints of S960 grade steel was studied by experimental testing, and statistical analyses using finite element (FE) modeling were performed to define geometric parameters and their effect on the stress concentration factor of the TIG-dressed fillet weld joints. Review of the literature and scientific publications indicated a need for studies related to both the fatigue durability of TIG-dressed ultra-high-strength steel (UHSS) weldments and the fatigue strength of these joints at high stress ratio. The results of the experimental fatigue tests showed that International Institute of Welding recommendations accounting for the effects of TIG-dressing on fatigue classes are too conservative for S960 grade steel, although the fatigue resistance of TIG-dressed UHSS fillet weld joints was found to decrease with increasing stress ratio. Statistical analysis of geometric variables and FE modeling with an idealized weld profile shape showed that toe radius and weld undercut have the greatest effect on stress concentration in TIG-dressed fillet weld joints. In addition, TIG-dressing was found to cause notable softening in the fusion line and heat affected zone of the TIG-dressed S960 weldments, which might have an effect on fatigue crack initiation and thus the fatigue strength of the structure.

Keywords: Fatigue strength; TIG-dressing; Stress ratio; Ultra-high-strength steel; Finite element analysis

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