Fatigue fracture assessment of 10CrNi3MoV welded load-carrying cruciform joints considering mismatch effect

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October 22, 2020

Abstract

Fatigue experiments and numerical simulations based on the Linear Elastic Fracture Mechanics (LEFM) theory were conducted on the Even-Matched (EM) and Under-Matched (UM) 10CrNi3MoV Load-carrying Cruciform Welded Joints (LCWJs). The study firstly experimentally investigated the Fatigue Crack Growth Rate (FCGR) of base metal, EM, and UM weldments. The corresponding Paris parameters as essential input data are provided to assess the fatigue crack propagation behavior for weld toe and weld root failure of LCWJs. On the one hand, the Stress Intensity Factors (SIFs) at weld toe and weld root were calculated considering the effects of LCWJ specimen geometries, initial crack types, and sizes. The comparisons between simulated results and standards analytical solutions were executed, which exhibit good accordance. It proved that the fatigue fracture simulation procedure based on LEFM is appropriate for the fatigue assessment of LCWJs. Eventually, it conducted the parametric analysis by predicted S-N curves, which included in the weld length, initial crack shape, initial crack size, penetration length, and materials fracture parameter, to explore some safety assessment reference lines for both failure modes of LCWJ.

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