

Correlation of Crack Initiation Parameters with Life Estimation for Very-High-Cycle Fatigue of High Strength Steels

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Summary

The researches on the behavior of very-high-cycle fatigue (VHCF) for high strength steels have become a new branch in the field of metal fatigue since 1980s. The characteristics of crack initiation and propagation for high strength steels in VHCF regime differ from those in low cycle and high cycle fatigue regimes. One of the most distinct phenomena for VHCF regime is the interior or subsurface crack initiation at inclusions or at other inhomogeneities. In fact, the period of crack initiation and early growth dominates the fatigue life, which is extremely evident for the fatigue process containing VHCF regime. This paper attempts to further investigate the crack initiation with the morphology of so-called fish-eye and fine granular area (FGA) or optical dark area (ODA) for high strength steels. Fatigue tests were carried out on a high carbon low alloy steel by using rotating bending (52.5Hz) and ultrasonic push-pull (20kHz) machines and the fatigue fracture surfaces were examined by scanning electron microscopy. The present results together with the previous ones showed the data of the stress intensity factor range (SIF) as a function of the dimension for fish-eye and FGA. The results also showed the data of FGA dimension as a function of related inclusion size. Based on the present results and the ones from literature, two models of fatigue life estimation were developed. One was taking into account the size of plastic zone at crack tip in relation with the value of SIF at FGA. The other was considering the fatigue damage cumulative process in relation with the microscopic parameters (inclusion size and FGA size) at the fracture region along with macroscopic quantities (tensile strength and stress level). The estimations are in good agreement with experimental results.

