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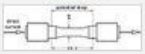
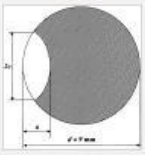
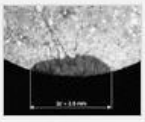
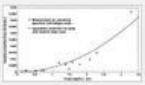
Article outline

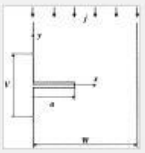
Figures and tables

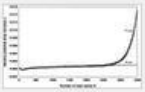


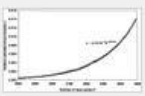












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Growth of naturally initiated fatigue cracks in ferritic gas turbine rotor steels

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Abstract

Smooth test specimens of 12% CrNiMoV and 1% CrMoV steel have been subjected to strain-controlled low-cycle fatigue loading. Several specimens were instrumented with potential drop probes. As fatigue cracks grew deeper than 0.2–0.3 mm, they caused a steadily increasing potential drop over the length of the specimen. These LCF tests were terminated after a certain fraction of the nominal life. A stepwise increasing high-cycle fatigue load was subsequently used to propagate the crack to fracture. The contour of the low-cycle fatigue crack could be identified on the fracture surface. In agreement with a model suggested by Tomkins, its growth rate was found to be proportional to the crack depth and to be a power function of the plastic strain amplitude. For an assumed initial crack depth of 50 μm, this relationship generally provided conservative life predictions deviating from the observed number of cycles by less than a factor of 5. A second model assumed the crack growth rate to be proportional to a power of the cyclic J integral. Using standard Paris type crack growth data, this model also tended to give conservative predictions, in particular for the longer lives. The deviation from the observed number of cycles was generally less than a factor of 3. The high-cycle fatigue tests permitted the fatigue limit of the cracked specimens to be determined. The threshold stress intensity range obtained from these tests consistently fell below that from tests with standard fatigue crack growth specimens.

Keywords

Fatigue crack growth; Fatigue limit; Low-cycle fatigue; Potential drop; Short cracks; Threshold stress intensity range