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ACCELERATING HIGH-CYCLE FATIGUE LIFE ESTIMATION USING XFEM AND GRADIENT ENHANCED DAMAGE MODEL

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Fatigue crack initiation and propagation is a main physical mechanism responsible for the fatigue failure process for plenty of safety-critical engineering components, such as turbine blades of aircraft engines. A better understanding of the fatigue life can be obtained by simulating the crack propagation behavior under cyclic loadings.

To study the fatigue failure process accurately using a conventional single scale time integration method, a large number of cycles needs to be simulated until the critical state is reached. The objective of this contribution is to develop a numerical approach which can be used to predict the high-cycle fatigue life time for a large number of loading cycles at reasonable computational cost.

A gradient-enhanced damage model is implemented and combined with the extended finite element method (XFEM). The model allows for a damage-based propagation criterion which can be extended to finite deformation analysis and for non-linear and inelastic materials. This work presents the application of the wavelet transformation-based multi-time scale (WATMUS) method to accelerate the time integration of damage growth for a large number of cycles. Once the gradient-enhanced equivalent damage variable reaches critical values along the crack front, the level set techniques embedded in the XFEM are used to deal with the propagation of the discrete crack front.

LITERATUR

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