Numerical evaluation of fatigue crack growth in polymers based on plastically dissipated energy

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Numerical evaluation of fatigue crack growth in polymers based on plastically dissipated energy

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Abstract

Paris-regime fatigue crack growth in polymers is simulated via a numerical procedure. The crack growth rate is calculated based on the assumption that crack extension is controlled by the plastically dissipated energy in the plastic zone around the crack tip. During Paris-regime crack growth simulations, the accumulation rate of plastically dissipated energy is obtained from a two-dimensional finite element model of a standard compact tension specimen and compared to the critical value required for crack growth, which is assumed to be a material property. Thus, the crack growth rate can be determined from finite element simulation for a material when this material property is known. Using this methodology, Paris-regime curves are constructed numerically and compared to experimental data. Two classes of polymers are investigated: those exhibiting frequency-dependent fatigue crack growth and those exhibiting frequency-independent fatigue crack growth. The numerically determined fatigue crack growth rates match well with the published experimentally-determined rates for both types of polymers.

Keywords: Paris' Law; Polymer; Time Dependent; Plastically dissipated energy; ABAQUS

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