Fracture and Fatigue Crack Growth Analysis

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Fatigue crack growth prediction has become an important topic in engineering, fracture mechanics, and NDT. Crack propagation is influenced by the mechanical properties of the material that are conveniently studied using DFT calculations. As a condition for structural stability the strain energy must be positive against elastic deformations which leads to restrictions regarding the elastic constants and elastic moduli B and G. Corresponding results are presented in the form of a stress vs strain curve. Using an energy optimization approach based on the Griffith theory the stress necessary to cause fracture and the critical crack length are calculated. For both microscopic and macroscopic cracks its growth and size are predicted and modeled from crack initiation until final rapture. The fatigue life of the component is calculated from the total number of load cycles using the Paris-Erdogan equation; improvements of the calculation are introduced to better model the rapid crack growth stage. Results are compared with those from structural health monitoring SHM which defines structural damage as a response to outside forces. Estimating the lifetime of a structure is important with regards to monitoring its ageing and degradation and to ensure its ability to properly perform its functions. It is a risk based analysis and can be used to determine the inspection cycle and thus enhance operational safety.