Fatigue Crack Propagation under Non-Proportional Loading: Experiments and Modelling

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Abstract

A number of engineering components suffer two or more independent sources of loading and this can lead to a stress-state which is non-proportional. A particular instance occurs in bladed disks or 'blisks' in gas turbines, where loading arises from rotation as well as from blade vibration. Tthere are a number of well-established theories to predict crack growth direction under multiaxial load, for example maximum tangential stress (MTS) or maximum strain energy (MSE), these do not necessarily cope well with non-proportional loading. The paper describes a number of experiments which subject a cruciform specimen to biaxial and bending loading. Crack growth trajectories are measured under a different range of load. These are compared to simulations using MTS or MSE. It is demonstrated that certain combinations of load lead to crack growth which is poorly predicted. Hence a modified criterion is suggested which better represents crack growth direction under the full range of loads.

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