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Crack Path and Life Prediction Under Mixed Mode Cyclic Variable Amplitude Loading Through XFEM

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Abstract

In the present paper, a mesh independent computational algorithm is developed and incorporated into a commercial finite element software (Abaqus) for automatized fatigue crack growth analysis under mixed mode variable amplitude loading conditions. The algorithm calculates the stress intensity factor (SIF) at predetermined small crack growth increments in the finite element software by using Extended Finite Element Method (XFEM) and predict the fatigue crack growth (FCG) path through local symmetry ($K_{II} = 0$) criterion. The aforementioned algorithm also computes the FCG life by means of cycle-by-cycle integration method through Nasgro equation based on the equivalent SIF range. Load history effects are also taken into account by using appropriate retardation models according to nature of the loading. For verification purpose, experimental crack path trajectories and fatigue life data available in the open literature are compared with computational results. Quite good agreements are obtained between the computed and the experimental results.

Keywords: Fatigue crack growth path;Fatigue crack growth life; Variable amplitude loading; XFEM;

1. Introduction

Fatigue cracks are crucial in various engineering fields as they are one of the major cause of structural failures. It is compulsory to assure the reliability of critical components and systems launching to service. Consequently accurate crack path and fatigue life estimation of components especially in aerospace industry is an issue that has primary importance from the reliability requirements point of view. Most of the industrial structures are usually under the action of mixed mode loading, therefore the propagating crack path is not as idealized as in damage tolerance approaches. For this reason, understanding of mixed-mode crack growth is indispensable for realistic FCG life and path prediction under complex loadings. For fatigue studies the experiments are inevitable in the aerospace industry, however due to their high cost, reliable computational

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