Macroscopic and local modelling of fatigue crack growth in generalised plasticity

Vincent Maurel, Centre des Matériaux, Mines ParisTech, UMR 7633, 91003 Évry

vincent.maurel@mines-paristech.fr

The aim of this study is to address crack growth modelling for LCF conditions within generalised plasticity. This scope is seldom analysed due to a lack of knowledge about the physical basis of crack growth within large scale yielding condition and subsequent difficulties to obtain reliable model. This study is based on isothermal LCF crack growth tests performed on a Nickel based superalloy material.

Two original models were built to deal with crack growth within generalised plasticity. Firstly, a macroscopic crack growth model was developed based on strain energy partitioning between elasticity and plasticity [1]. To model explicitly the crack growth, local approach was promoted mixing a Cohesive Zone Model (CZM) [2-3], to account for localisation, and bulk strain energy, to associate dissipation effect. This latter energy was coupled with the CZM using a specific interface element with a non-local formulation to inhibit mesh size effect. Validation on experimental crack growth analysis will be discussed for macroscopic and local approach.

References

[1] V. Maurel, L. Rémy, F. Dahmen, and N. Haddar. An engineering model for low cycle fatigue life based on a partition of energy and micro-crack growth. International Journal of Fatigue, 31(5):952 – 961, 2009.

[2] J. Besson and S. Bugat. Modélisation mécanique de la corrosion sous contrainte : modèle de zone cohésive appliqué à la corrosion par l'iode des alliages de zirconium. Colloque National MECAMAT - Aussois, Approches multi-échelles en mécanique des matériaux:200–208, 2006.

[3] V. Maurel, Vers une compréhension des mécanismes menant à la ruine des revêtements pour aubes de turbine et de la fissuration en plasticité généralisée, Habilitation à Diriger des Recherches, Université Pierre et Marie Curie (UPMC - P6), 1er juillet 2013.

Keywords

Cohesive Zone Model, fatigue crack growth, generalised plasticity, non-local approach