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Validation of initial crack propagation under vibration fatigue by Finite Element analysis

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Abstract

This manuscript proposes, for the first time, the use of the Virtual Crack Closure Technique (VCCT) applied to a Finite Element (FE) model undergoing vibration fatigue. This work presents the simulation and validation of the early propagation in a laminate CFRP component, which is measured by the response phase during the test. Here, the FE model supports the comprehension of a psychical phenomenon that is experimentally measured but poorly understood by the only means of experiments. Two FE models are built to calculate, under the same experimental conditions of the fatigue test, the response phase at a critical moment of damage occurrence. The VCCT is applied, by using modal displacements, to measure the crack length as a function of number of cycles. The novelty of this paper is to show that the Paris' law can be used for explaining the change in response phase while the crack opens. Both a 2D and a 3D model will be used to numerically simulate the experimental measurements. The vibration loading ratio is typically $R = -1$ where the small forces at the resonance generate very large modal displacements. Hence, the paper presents a qualitative analysis carried out by the VCCT, the results of which show a strong correlation between changes the response phase and energy release rates.

Keywords: Initiation, Fatigue, Resonance testing, Dynamic VCCT

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