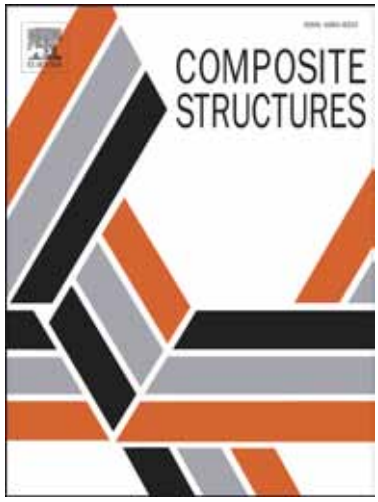

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DELAMINATION GROWTH IN POLYMER-MATRIX FIBRE COMPOSITES AND THE USE OF FRACTURE MECHANICS DATA FOR MATERIAL CHARACTERISATION AND LIFE PREDICTION

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ABSTRACT

The growth of delaminations in polymer-matrix fibre composites under cyclic-fatigue loading in operational aircraft structures has always been a very important factor which has the potential to significantly affect the service-life of such structures. The recent introduction by the Federal Aviation Administration (FAA) of a 'slow growth' approach to the certification of composites has further focused attention on the experimental data and the analytical tools needed to assess the growth of delaminations under fatigue loads. Specific attention is given to the test and data-reduction procedures required to determine a 'valid' rate of fatigue crack growth (FCG), da/dN, versus the range of the energy release-rate, ΔG, (or the maximum energy release-rate, G_{max}, in a cycle) relationship (a) to characterise and compare different types of composites, and (b) for designing and lifing in-service composite structures. Now, fibre-bridging may occur behind the tip of the advancing delamination and may cause very significant retardation of the FCG rate. Such retardation effects cannot usually be avoided when using the Mode I double-cantilever beam test to ascertain experimentally the fatigue behaviour of composites, so that a means of estimating a valid (i.e. ideally a 'retardation-free' or, at least, a very low-retardation) relationship is needed. The present paper presents a novel methodology, that is based on a variant of the Hartman-Schijve equation, to ascertain a valid, 'retardation-free', upper-bound FCG rate curves.

Keywords: Delamination growth; impact damage; lead delaminations; fatigue threshold; modelling; scatter.