Fatigue behaviour of composite bonded joints under mixed-mode loading

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ABSTRACT. Aim of the present paper is to investigate the possibility of defining a fatigue model suitable to describe crack propagation in composite bonded joints under I+II mixed modes cyclic loading. Bonded joints manufactured from carbon/epoxy laminates and bonded with the two-part epoxy adhesive 9323 B/A by 3M adhesive were prepared.
Static behaviour was investigated on a closed loop controlled MTS Minibionix servo-hydraulic machine equipped with a 15 kN load cell. Crack opening was monitored by means of the displacement transducer of the testing machine and the crack length was monitored by means of a travelling optical microscope.
After that, fatigue tests were carried out under load control, with a nominal load ratio (defined as $R=F_{min}/F_{max}$) equal to 0.1. During static and fatigue tests the loading mode (and thus the mode-mixity) was varied from pure mode I (on DCB specimens), to mixed I+II loading (on MMB specimens) and eventually to pure mode II (ENF specimens)
The experimental data were then processed by assuming as crack driving force the maximum total energy release rate or range of variation of the total energy release rate, for static and fatigue tests, respectively.
The results obtained so far indicate that the critical energy at fracture for mode II in a static test is about 3 times that for mode I. Concerning the fatigue tests, the observed crack propagation rates were plotted as a function of the range of the total strain energy release rate. It was seen that the experimental data tend to collapse to the pure mode II curves even in the presence of significant contributions of the mode I (mode I /mode II mixity ratio = 1.8).

KEYWORDS. Composite bonded joints; Mixed-mode loading; Fatigue.