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# ASSESSMENT OF MODE I FATIGUE DELAMINATION OF COMPOSITES THROUGH A RAPID TESTING METHOD

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## ABSTRACT

Fatigue resistance is always a concern in most structural components as it can compromise their integrity at a stress level below the quasi-static strength of the material. For this reason, it is crucial to evaluate the material's fatigue behaviour and assess the component's lifetime. The fatigue behaviour of interlaminar cracks in composite materials can be divided into onset and crack propagation. Fatigue onset refers to the required number of cycles to propagate an existing crack for a given load level or energy release rate. Once the crack is initiated, the propagation of the crack is described by the crack propagation curves relating the crack growth rate (da/dN) to the applied load level. This curve allows obtaining the linear propagation of the crack defined by the Paris law and the load threshold below which the crack is not propagating. To avoid self-heating of the material during the fatigue test and its effect on the fatigue behaviour, the test frequency must be kept low, around 1-5 Hz, leading to long testing times. Then the characterisation of the onset and the crack growth rate is highly time-consuming, especially when reaching long lives between 1 and 10 million cycles. Despite the testing time can be cut down by using a multi-test device [1] by testing several specimens simultaneously, it is still time-consuming to determine the threshold of the material. Thus, more research is required to develop new testing techniques to characterise the fatigue behaviour of composite materials in a fast way.

This work aims to use a new testing procedure based on the damage evolution in the fatigue specimen developed for metallic materials [2]. The method consists of stepwise increasing load amplitude up to the complete fracture of the specimen while monitoring the fatigue damage using the compliance of the specimen throughout the test. The procedure of the rapid method for metallic materials described in Figure 1 is transferred to composite materials. Double Cantilever Beam (DCB) specimens have been successfully tested using the rapid method developed for composite materials to assess the mode I fatigue delamination of composite material. The results obtained in only one day show good agreement with the conventional testing method currently used to determine the crack onset and propagation. Although the standard testing procedure is still required for component designing purposes, the novel testing method help to define the load levels to be tested in the multiple testing devices and significantly reduces the testing time. The method could also be used to discern between different materials or manufacturing conditions that influence the fatigue resistance of composite materials.

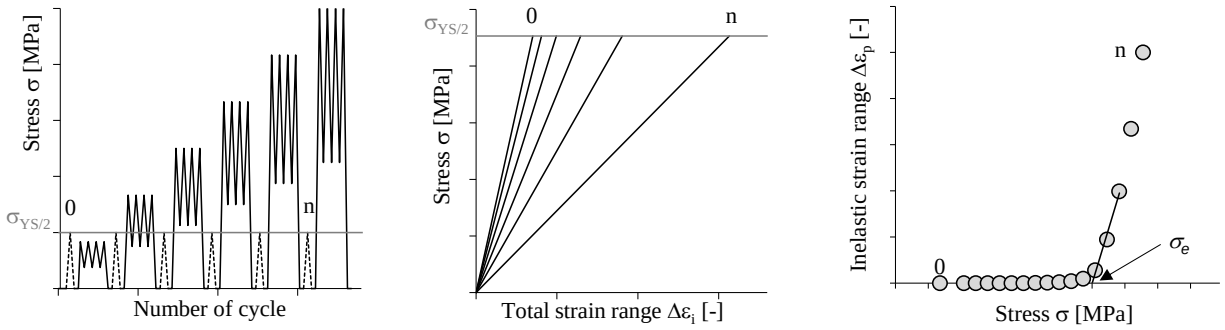


Figure 1: Schematic representation of the rapid test procedure for metallic materials. a) load sequence, b) strain variation for a given stress and c) strain evolution against the applied stress of each fatigue block.

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