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Delamination Tests of DCB Specimens Composed of Woven Composites

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In this investigation, quasi-static fracture tests double cantilever beam (DCB) woven composite specimens containing a straight through delamination are presented. The specimen is shown in Fig. 1. The fibers are carbon 300T which are transversely isotropic. The epoxy matrix is 913 and is isotropic. Each ply is a balanced plain weave of carbon fiber yarn in an epoxy matrix. The plies are laid up so that they alternate between a 0°/90° and a +45°/ − 45° weave. There are 15 plies with the delamination located between the seventh and eighth plies. Thus the interface is between a 0°/90° weave and a +45°/ − 45° weave. Each of these plies is anisotropic.

Mechanical properties were calculated by means of the High Fidelity Generalized Method of Cells (HFGMC) [1]. The specimens are based on the ASTM Standard D5528-01 [2] which is used for testing unidirectional composites. In order to obtain a relation between the interface energy release rate Gi, the mode mixity phase angles, the applied load and crack length, finite element analyses were carried out. The stress intensity factors were determined by means of an interaction energy integral. To this end, the Stroh formalism [3] was used to determine the first term of the asymptotic expressions for the stress and displacement fields in the neighborhood of the delamination front. Similar methods have been used for straight through delaminations in cross-plies [4, 5].

The experimental set-up consists of an Instron loading machine (no. 8872) with a load cell of maximum load 250 N. This small load cell is required since the maximum load at fracture is approximately 60 N. The Instron measures the load as a function of time.

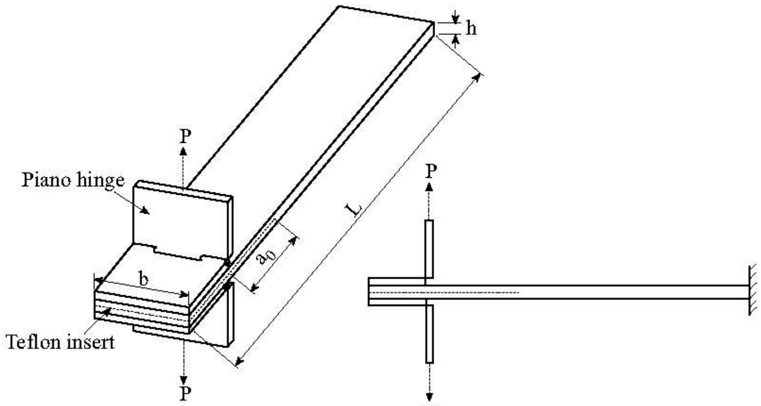

Figure 1: Double cantilever beam woven composite specimen.

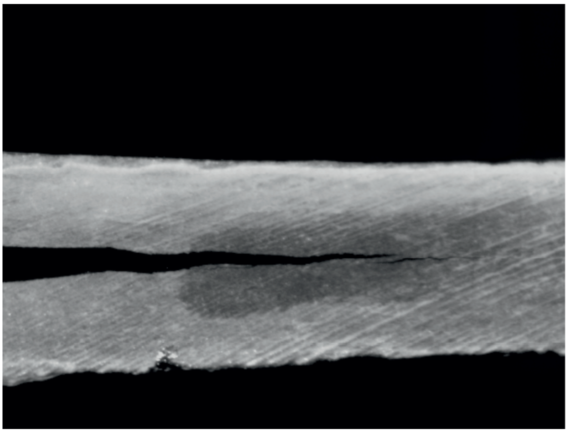

Figure 2: Crack in the DCB specimen.

The cross-head displacement is increased quasi-statically. The applied load as a function of the crack opening displacement (COD) is required. The COD is measured using a camera-video system, together with image processing. The COD is found as a function of time. In this way, the load and COD are synchronized. In order to continuously monitor the propagation of the crack, a second video imaging system was used. The photographs were taken with a PixeLink camera and software through a Naviatar modular optical microscope. These were also synchronized with respect to time. The crack jumps ahead at certain cross-head displacements. The crack length is measured and synchronized with the applied load. An example of one of these pictures is shown in Fig. 2. Results for the critical energy release rate and mode mixity phase angles will be presented.

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