Toughening of adhesively bonded joints using CFRP patterning

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Objectives / Description / Main outcomes

An innovative damage tolerant CFRP patterning design for bonded joints to enhance the joint's fracture toughness and reduce the crack propagation rate by crack deflection mechanisms was proposed to increase the adhesively bonded joints' reliability in primary structures. For that, the following steps were carried out:
First, a literature review was done to identify the main mechanisms used to toughen adhesively bonded composite joints. Particular attention was given to CFRP patterning strategies, so laminates with five distinct stacking sequences were studied as substrates for secondary joints. Next, double cantilever beam specimens were bonded with two different structural adhesives: bi-component epoxy paste and a film adhesive with the carrier.
Quasi-static tests were performed in the Department of Aerospace Structures and Materials of the TU Delft. Visual inspection aimed by a microscopy camera was used on the specimen's lateral to track the crack path during the tests and, for some CFRP lay-ups, identify matrix cracking and crack deflection. A high-frequency camera was also used to get photos every four seconds to monitor crack propagation. Aiming to monitor the damage propagation within the DCB bonded composite joints, an acoustic emission (AE) method was applied for all the specimens, as shown in Figure 1.
Two main crack propagation paths could be observed during the tests: cohesive failure and matrix cracking that promotes crack deflection to other composite layers and final delamination, Figure 2. The competition between the crack propagation within the adhesive layer and matrix cracking changes the bonded joints' mechanical behaviour, increasing their onset fracture toughness. The main outputs of this work will be present in the European Conference of Composite Materials (ECCM – 2022).
This project also promoted knowledge exchange and a common research agenda around the topic bonded primary structures within the context of a roadmap to certification. Including also networking with high-motivated researchers from the host university contributing to a multi-cultural experience and stimulating personal and professional growth.

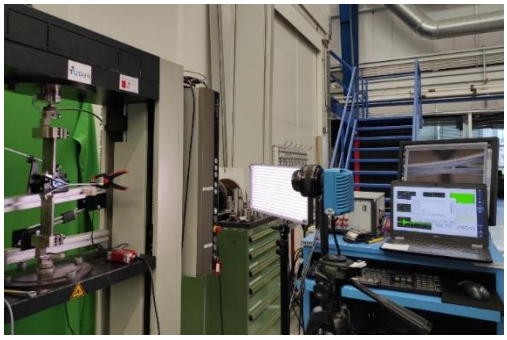

Figure 1: Testing set-up - DCB quasi-static tests.

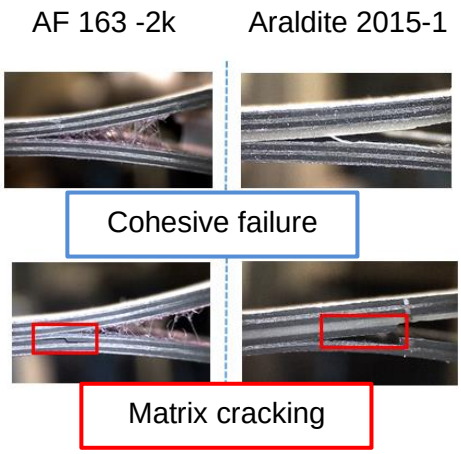

Figure 2: crack propagation paths.

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