IN-SITU DAMAGE CHARACTERISATION OF ADHESIVE BONDED CFRP SPECIMENS

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Summary: In this paper, in-situ computed tomography is used to determine the crack progression in adhesive bonded CFRP during slotted single lap shear test.

1. INTRODUCTION

Nowadays the material system carbon fibre reinforced polymers (CFRP) is widely used in aeronautic industries for their special properties such as light weight, high specific stiffness, high specific strength and the high corrosion resistance [1]. An important manufacturing issue is the bonding of CFRP plates. Therefore adhesives are widely used. A main advantage of the adhesives is the homogenous stress distribution in comparison to other joining techniques [2].

The microstructure of the jointed area is decisive for the mechanical strength of adhesive jointed CFRP plates. Therefore, high resolution computed tomography (XCT) as common non-destructive technique (NDT) is used to characterise defects in CFRP specimens. In the past in-situ XCT has already been used to investigate damage mechanism in CFRP [3-4]. H. Kunz et al. showed a technique for particle tracking in polyurethane adhesive bonded CFRP and steel with in-situ XCT while performing a lap shear test [5].

In this paper, the method in-situ computed tomography is used to determine the damage progression in adhesive during an adapted slotted single lap shear test. With interrupted in-situ XCT measurements under different load conditions it is possible to mechanically test the adhesive jointed CFRP plates and to visualise and study the influence of different CFRP material combinations on the crack progression and propagation.

2. EXPERIMENTAL METHOD

A supported epoxy adhesive was used to bond a CFRP fabric plate with another CFRP fabric plate and a CFRP fabric plate with a unidirectional (UD) CFRP plate. In both cases the adhesive layer is 0.2 mm thick. The adapted slotted single lap shear test specimens were cut out of the bonded plates by jet cutting. The experiment was performed with the CT5000 5 kN in-situ tensile stage (Deben) at room temperature. The specimens were scanned with a Nanotom 180NF XCT device (GE phoenix | X-ray) with a voxel size of $(8\ \mu m)^3$. This system consists of a sub-µ-focus X-ray tube and a 2304x2304 pixels flat panel pixel detector (Hamamatsu). An interrupted slotted single lap shear test, with adapted dimension, was used to identify damage at several load stages.

3. RESULTS

The progression of damage could be characterised by registering the individual load steps on top of each other. In particular the first results indicate that the observed cracks are continuously growing through the adhesive layer and the CFRP for increasing load (Fig. 1(c)). It can be concluded that the crack origin and propagation can be tracked with an interrupted in-situ measurement.

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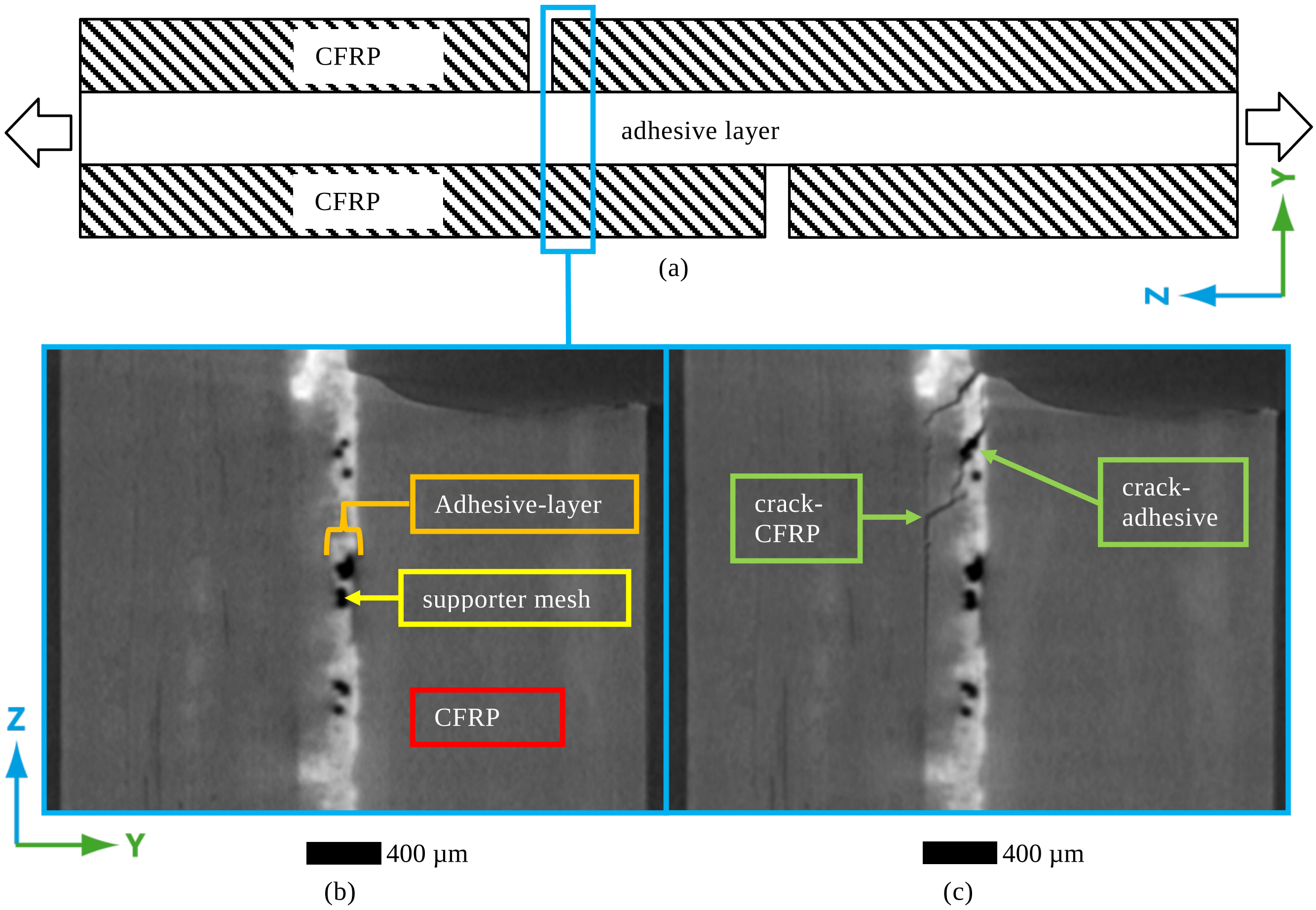

Figure 1: (a) sketch of specimen. XCT slice image (b) shows the adhesive bonded CFRP unstressed. At a certain load (c) a crack trough the adhesive layer and the CFRP matrix is visible.

The purpose of this work is to gain deeper knowledge of the damage initiation and propagation of adhesive bonded CFRP of two different CFRP material combinations. As a result the influence of the substrate on the damage mechanism is determined.

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