STUDY OF THE INITIAL AND PROPAGATION OF TRANSVERSE CRACKS FOR CARBON FIBER PRE-PREG COMPOSITE SUBMITTED TO TRANSVERSE LOADING AND PRE-DAMAGED BY SHEAR LOADING

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Abstract

The damage evolution and the development of transverse cracking in cross-ply laminates subjected to static uniaxial loading have been extensively studied in the literature [1–5]. A reference bibliography model has been developed and implemented for simulating the two-dimensional strain distribution in transverse cracked cross-ply laminates.

A key point is to better understand their complex mechanisms of degradation, from the process to the final failure. This requires the development of multiscale models than can capture fiber/matrix debonding, transverse cracking, delamination, and all potential interactions between these damages. Figure 1 present different failure mechanisms for carbon fiber pre-preg composite. Rigorous models are developed based on micromechanical approaches [1-5].

It is well known that laminated composites can exhibit two main mechanisms of degradation depending on the in-plane loading. Shear loading mainly induces the so-called “diffuse” damage manly related to fiber/matrice debonding. Transverse loading is responsible for the development of transverse cracks that completely percolate throughout the whole thickness of the single ply. An important material parameter in composite design is the fracture toughness to transverse cracking that is commonly identified on multi cracking testing with cross-ply laminates. The primary objective is to identify the effect of pre-existing diffuse damage on this fracture toughness. The material studied is [0, 90]s, carbon fiber pre-preg T700/M21.

The experimental part of this work is based on three stages: the first stage is the elaboration of materials: Laminates plates of carbon fiber pre-preg were laid up in a [0, 90]s configuration with dimensions 300 * 300 * 1 mm and cured in compression molding with the manufacturer’s recommendation at a single dwell temperature of 180 C. The second stage is to characterize the material in the shear direction, and to study the evolution of damage. Many static and quasi static tests are realized on the [±45,-45]s samples obtained by cutting with a numerical control machine. The digital image correlation is used to determine the evolution of strain field at the surface during the mechanical tests. The results of this stage are the shear
damage evolution versus the applied measured strain or stress and the evolution of transverse cracks numbers after different level of damage. In the third stage, we describe the evolution of transverse cracks using the X-ray tomography and coupled with small mechanical testing machine. The samples [0, 90]s used at this stage are cutting by water jet machine from pre-damaged samples at different levels of shear damage, (0, 0.05, 0.1, 0.15, 0.20, …).

The goal of our numerical work is to identify the damage model parameters from the shear damage test, and to identify the parameters of the evolution law for transverse cracks numbers and the G-criterion $G_c$.

Figure 1: Sketch of damages induced in carbon fiber pre-preg laminates [0, 90].

REFERENCES


