CONTRIBUTION OF ULTRASONIC NDT TO THE ASSESSMENT OF THE EFFECT OF OUT-OF-PLANE WAVINESS DEFECTS ON THE MECHANICAL STRENGTH OF THERMOPLASTIC COMPOSITE MATERIALS

ABSTRACTS

In the aerospace industry, mass reduction has been an important economic and environmental issue for many years. The replacement of metallic materials by composite materials for mechanically stressed structural parts is a real technological challenge. In the aeronautic industry, the need for increased production rates and reduced costs led to the introduction of thermoplastic resins (TP) which can be used to develop complex-shaped structures. However, the shaping of TP prepregs can create severe damage such as fiber breakage, disorientation of the layer, in plane or out-of-plane waviness. The consolidation step of the manufacturing process can also generate defects such as dry or resin-rich areas and high porosity rate in intra- or inter-layer areas. The optimal use of such complex composite structures requires both non-destructive and mechanical testing to detect and characterize these defects. The aim of the present paper is to closely link ultrasonic NDT measurements to the effect of defects on the structural mechanical integrity.

In this study, various defect manufacturing techniques are used to generate calibrated out-of-plane waviness defects in carbon-fiber reinforced TP composite plates. All manufactured plates are inspected and characterized by NDT: first, ultrasonic testing to precisely locate and size the defects; then, laser vibrometry to measure the mechanical modulus. The accuracy of those NDT measurements is then validated by comparisons with optical microscopy observations. Finally, compression tests are carried out on several specimens with and without defects so that the non-destructive characterizations can be linked to the loss of mechanical properties induced by out-of-plane waviness.

KEYWORDS

ultrasonic NDT | thermoplastic composite | out-of-plane waviness defects | laser vibrometry |