DAMAGE MODES ASSESSMENT OF PULTRUDED GLASS FIBER REINFORCED MATERIALS WITH ACOUSTIC EMISSION SIGNAL ANALYSIS

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Abstract

Composite materials are being increasingly used for the realization of lightweight structures. However, their production is still related to a full or partial manual process; this raises the cost of such products and makes it difficult to spread in an automated high-volume industrial process. Pultrusion is a process for manufacturing constant-section composite profiles. This technology consists of a matrix extrusion process, where the fibers are pulled; this leads to a good alignment of the fibers before the matrix polymerizes. It is also a cost-effective and highly automatable process. All those features allowed recently to spread these materials in civil structures, as bridges, industrial sheds and anti-noise panels. However, the proliferation of these applications is delayed by the limited knowledge on fatigue strength and damage modes of these materials. For these reasons, an experimental study on pultruded materials has been developed. A traditional fatigue testing plan was supported by acoustic emission testing. Each specimen was monitored through all the test, recording acoustic emission events. It was also possible to localize events and to predict failure position thanks to the use of multiple sensors. The characteristics of Acoustic Emission signals were monitored and Scanning Electron Microscope observations of specimens were made, allowing to correlate acoustic emission features (such as energy and amplitude) to damage modes (fiber or matrix failure, fiber slipping and delamination).

Keywords Composites; Pultruded materials; Fatigue; Damage; Acoustic Emission.

1. Introduction

The use of lightweight materials, especially composites, allow on one hand to manufacture lightweight structures (with all the benefits deriving from it), but on the other hand requires a finer knowledge of their characteristics and of the damage behavior under different loading conditions. The poor knowledge of material behavior, in facts, results in the safety factors to be kept higher; thus the development of some experimental technique to monitor the actual state of the material and the development of the ongoing damage processes is required.

Composite materials have good rigidity-to-weight and strength-to-weight ratios, thanks to the combination of properties of the matrix and the reinforcement. However most of the production means rely on manual steps and therefore the costs of an industrial product tend to increase. Pultrusion is an automated technological process for the continuous production of constant section composite profiles, which involves the extrusion of the matrix