Available online at www.sciencedirect.com

ScienceDirect

Procedia Manufacturing 13 (2017) 380–387

Procedia MANUFACTURING

www.elsevier.com/locate/procedia

Manufacturing Engineering Society International Conference 2017, MESIC 2017, 28-30 June 2017, Vigo (Pontevedra), Spain

An infiltration strategy to repair Carbon Fiber Reinforced Polymer (CFRP) parts

R. Garcia[a], M. Linke[b], S. Neßlinger[b], J.A. García-Manrique[a,]*

[a]*Institute of Design for Manufacturing (IDF), Universitat Politècnica de Valencia (UPV), Spain*
[b] *Hamburg University of Applied Sciences (HAW Hamburg), Hamburg, Germany,*

Abstract

This paper presents a methodology to determine the damage levels of laminate carbon fibre reinforced plastics (CFRP) parts after controlled impacts. These techniques will be used to perform a re-infiltration technique to repair composite parts and to reduce maintenance costs. It will be included the manufacturing processes, material characterization and the application of the AITM-0010 standard. Also, it is propose the use of NDT Ultrasonic inspection to determine and characterized the degree of the damage measured. This NDT method uses an advanced pulse-echo technique that through allow exploration of different angles, shapes and positions of defects.

Peer-review under responsibility of the scientific committee of the Manufacturing Engineering Society International Conference 2017.

Keywords: Fiber Reinforced Plastics, Impact Damage, Repair, Compression-After-Impact Testing, Ultrasonic Testing.

1. Introduction

Nowadays the needs to make reparations in Carbon Fiber Reinforced Polymer (CFRP) are growing, due to the high costs of manufacture and the continuous impacts that usually suffer the parts fabricated with these materials (aeronautics, wind energy, boats, automobile, etc.). The traditional method of repairing CFRPs has been to remove the damage-affected area and replace it with a patch of similar characteristics [1]. This technique needs a later finish

* Corresponding author. Tel.: +0-000-000-0000 ; fax: +0-000-000-0000 .
E-mail address: author@institute.xxx

2351-9789
Peer-review under responsibility of the scientific committee of the Manufacturing Engineering Society International Conference 2017.
10.1016/j.promfg.2017.09.024

to get surfaces free of defects. Obviously, it is a technique of high cost, but that has given satisfactory results. Its main advantage is that is certified by the aeronautical industry and therefore its use is widespread. However, this process has a number of important drawbacks, such as the time required, adds weight to the structure and the initial mechanical properties of the component cannot always be achieved.

An alternative to this CFPR parts repair process is to use a resin re-infiltration technique. This technique involves the injection of a resin of low viscosity into the damaged area by an impact. Prior to infiltration, it is necessary to know in detail the geometry of the internal damage and sometimes it is necessary to define a drilling strategy on the part to communicate all the cavities and internal cracks. In this way the re-infiltration can be made from a single injection point and one or more vents. This technique is under development and therefore is not yet certified for the civil aviation industry. Actually, this technique is allowed for performing cosmetic repairs only.

The proposal repair method based on Liquid Resin Infusion, the goal is to make the resin flow from one side of the part to the other by filling all the cracks and delaminations. The repair process includes the following steps [2]: material preparation, pre-heat of the repair components, vacuum, resin Infusion, cures

2. Materials

During this work the following materials have been used:

- Pre-impregnated biaxial fabric: Prepreg RC200T with epoxy resin (SE84 LV). It has a basis weight of 200 gr/sqm and its nominal thickness after cured is set to approximately 0.2 mm. It has a module of 72 GPa in its main direction with a fiber Vf (Fiber volume) of 58%.
- Unidirectional prepreg: Pre-impregnated fiber T700 HS with epoxy resin (SE84 LV). Its weight is 300 gr/sqm and its thickness after curing process is 0.3 mm. It has a module of 131 GPa (E1) and with a fiber Vf of 63%.

Configuration for the laminate of the test pieces: WV45/2UD0/UD90/2UD0/WV45 (WV: woven CF with 45º orientation, UD: unidirectional CF with 0º/90º orientation, Number: Indicates the number of layers when is different from one).

2.1. CFRP specimens

Using glass molds, treated with releasing agent or film, the prepreg layers were applied with previously disclosed orientations and then vacuum is applied (-1 bar). The heat-up cycle of 1° C per minute starts until the temperature reaches 80º C. With the oven stable, keeping the vacuum on for 12 hours. As shown in figure 1 the machining process of the CFRP has been carried out by means of a CNC machine of 3 axes. Six specimens (100*150 mm) taken from each “Out Of Autoclave” sheet (400 * 400 mm).

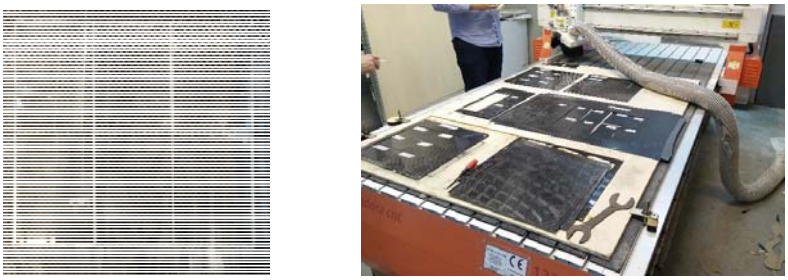

Fig. 1. Specimens