World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:10, No:01, 2016

Repair of Thermoplastic Composites for Structural Applications

Authors : Philippe Castaing, Thomas Jollivet

Abstract : As a result of their advantages, i.e. recyclability, weld-ability, environmental compatibility, long (continuous) fiber thermoplastic composites (LFTPC) are increasingly used in many industrial sectors (mainly automotive and aeronautic) for structural applications. Indeed, in the next ten years, the environmental rules will put the pressure on the use of new structural materials like composites. In aerospace, more than 50% of the damage are due to stress impact and 85% of damage are repaired on the fuselage (fuselage skin panels and around doors). With the arrival of airplanes mainly of composite materials, replacement of sections or panels seems difficult economically speaking and repair becomes essential. The objective of the present study is to propose a solution of repair to prevent the replacement the damaged part in thermoplastic composites in order to recover the initial mechanical properties. The classification of impact damage is not so not easy : talking about low energy impact (less than 35 J) can be totally wrong when high speed or weak thicknesses as well as thermoplastic resins are considered. Crash and perforation with higher energy create important damages and the structures are replaced without repairing, so we just consider here damages due to impacts at low energy that are as follows for laminates : − Transverse cracking; − Delamination; − Fiber rupture. At low energy, the damages are barely visible but can nevertheless reduce significantly the mechanical strength of the part due to resin cracks while few fiber rupture is observed. The patch repair solution remains the standard one but may lead to the rupture of fibers and consequently creates more damages. That is the reason why we investigate the repair of thermoplastic composites impacted at low energy. Indeed, thermoplastic resins are interesting as they absorb impact energy through plastic strain. The methodology is as follows: - impact tests at low energy on thermoplastic composites; - identification of the damage by micrographic observations; - evaluation of the harmfulness of the damage; - repair by reconsolidation according to the extent of the damage ; -validation of the repair by mechanical characterization (compression). In this study, the impacts tests are performed at various levels of energy on thermoplastic composites (PA/C, PEEK/C and PPS/C woven 50/50 and unidirectional) to determine the level of impact energy creating damages in the resin without fiber rupture. We identify the extent of the damage by US inspection and micrographic observations in the plane part thickness. The samples were in addition characterized in compression to evaluate the loss of mechanical properties. Then the strategy of repair consists in reconsolidating the damaged parts by thermoforming, and after reconsolidation the laminates are characterized in compression for validation. To conclude, the study demonstrates the feasibility of the repair for low energy impact on thermoplastic composites as the samples recover their properties. At a first step of the study, the “repair” is made by reconsolidation on a thermoforming press but we could imagine a process in situ to reconsolidate the damaged parts.

Keywords : aerospace, automotive, composites, compression, damages, repair, structural applications, thermoplastic
Conference Title : ICCM 2016 : International Conference on Composite Materials
Conference Location : Paris, France
Conference Dates : January 21-22, 2016