SHAPE MEMORY ALLOY HYBRID COMPOSITES FOR AERONAUTICAL APPLICATIONS

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Summary. The goal of this work is to analyse and compare the behaviour of thermoplastic composites and Shape Memory Alloy Hybrid Composites (SMAHCs) for aeronautical applications, based on findings from numerical analyses and experimental tests. In this study, SMAs are used to improve the composite impact response and energy absorption thanks to the superelastic effect.

ABSTRACT

The relatively poor impact performance of polymer matrix composite materials, necessitates the development of more conservative and heavier designs or alternative materials solutions. One possible solution is through the use of hybrid materials able such as glare, or shape memory alloys.

This paper summarizes research on improving the impact performance of polymer matrix composites by embedding shape memory alloys (SMA) in laminates. The paper describes the manufacturing technology to produce SMA-reinforced these laminates and impact test results.

Impact results demonstrated a significant increase of the energy by laminates. A clear increase of the composites toughness and very high levels of absorbed energy before failure was observed.

This is mainly attributed to the ability of SMA materials to undergo large amounts of elastic and plastic deformation, at moderately high stresses. [1], [2].

An extensive test campaign was performed to assess the stiffness and strength properties of the reinforced carbon fibre (CF) thermoplastic and of the SMAHC hybrid material based on PPS matrix.

The impact test results, performed at different energy levels, show that hybrid specimens
have a greater ability to absorb impact energy with respect to structures made with traditional thermoplastic composites and to reduce the risk of delamination of the structures during impact, [3]. In addition, the SMAHC specimens show a reduced delamination area as observed by Non Destructive Evaluation (NDE) of the impacted specimens using ultrasound methods.

This study investigated numerically the impact damage behaviour of carbon fibre/epoxy composite plates embedded with superelastic shape memory alloys. The results showed that for low velocity impact, embedding SMA wires into composites lead to an increase of the damage resistance of hybrid composites structures when compared to conventional composites structures. This is due to the fact that SMA wires can absorb kinetic energy during the impact due to their superelastic and hysteretic behaviour. The superelastic effect is due to reversible stress induced transformation from austenite to martensite. If a stress is applied to the alloy in the austenitic state, large deformation strains can be obtained and stress induced martensite is formed. Upon removal of the stress, the martensite reverts to its austenitic parent phase and the SMA undergoes a large hysteresis loop and a large recoverable strain is obtained. This means that the presence of the hybrid fabric helps to evenly distribute the impact energy in the specimens so as reported in the experimental tests, too.

REFERENCES