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EVALUATION OF THE DAMAGE TOLERANCE OF THIN SANDWICH MATERIALS

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ABSTRACT

The sandwich materials can be adapted to various structural applications but, on another hand, are exposed to a large variety of damages, due to their advanced anisotropy and inhomogeneity. This aspect creates the need of careful evaluation of the damage tolerance under various loading conditions, in particular under low velocity impact events. The paper presents the results obtained in the assessment of impact and post-impact behaviour of thin sandwich sandwiches used in the structure of a wind turbine runner, meant to maximize its in service reliability.

Keywords: sandwich material, damage tolerance, low velocity impact, infrared thermography.

INTRODUCTION

The sandwich type composite materials offer a wide structural flexibility, due to the number of parameters that can be handled in order to meet the design requirements in terms of mechanical performance and safety. For this reason, it is highly necessary to evaluate their damage tolerance, a key factor that assures long term in service reliability.

The sandwich materials studied in this work are intended to be used in the structure of a small wind turbine runner (Constantin 2016). The thin sandwiches layout involve a single or double coremat® core, interleafed between glass fibre reinforced polyester (GFRP) skins. The total thickness ranges between 7 mm for the single core and 12 mm for the double core sandwiches. Their damage tolerance was evaluated following their behaviour after being subjected to low velocity impact events, considered to be the most invasive ones for layered composites. The evaluation was made by monitoring the impact force history curves, by non-destructive inspections (NDI) and by measuring the residual mechanical performance of the impacted sandwiches.

RESULTS AND CONCLUSIONS

The low velocity impact tests have been performed at 10 J, 20 J and 30 J levels, using an instrumented impact hammer. The shape of the impact force history curve is considered to be a reliable indicator of the damage state and its consequences upon the residual mechanical performance (Constantin 2008) (Feng 2013). The rather smooth shapes of these curves have justified the results obtained during the compression after impact (CAI) tests, showing a more

or less unchanged resistance under compression loading. Nevertheless, the bending under impact (BAI) tests proved a clear diminishing of the correspondent residual strength with the increase of the impact energy level (Fig. 1).

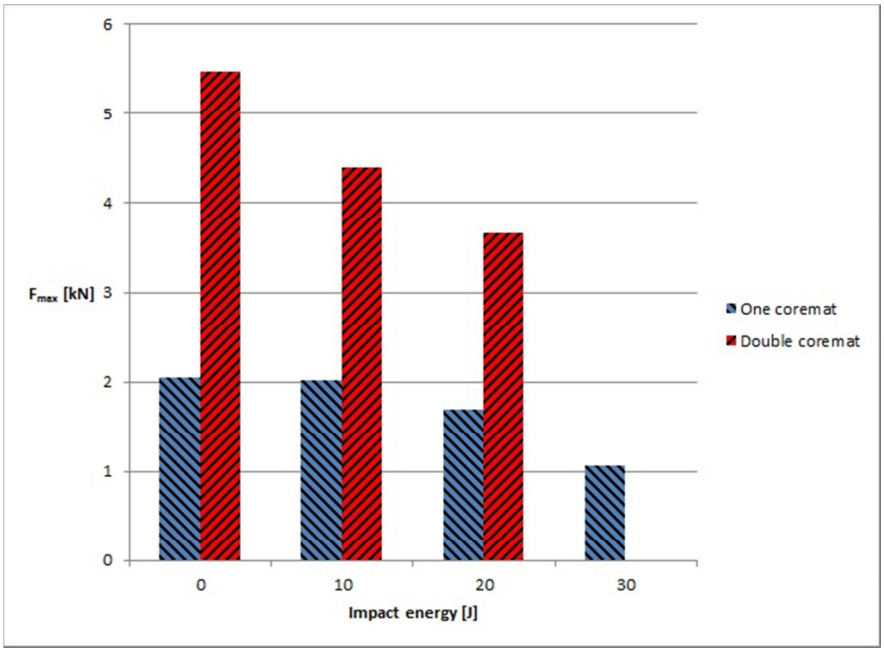

Fig. 1 - Residual bending strength obtained for impacted thin sandwiches.

This result is in accordance with the thermograms obtained using active infrared thermography (IRT), in the lock in variant, which has put in evidence different damaged states around the impact area.

The study shows that the BAI tests are more appropriate to evaluate the residual mechanical properties of sandwiches. Adequate correlation between that results and the images obtained during NDI work can lead to accurate prediction of the damage tolerance of such materials.

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