Hail Impact Model for Hybrid Laminar Flow Control (HLFC) Structure

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ABSTRACT

Weight and fuel reductions are key factors in the increase of composite materials in aeronautical structures. Hybrid laminar flow control (HLFC) is considered as an active drag reduction system. A delay in the boundary layer transition from laminar to turbulent flow can be accomplished applying suction over the first 10–20% chord position. Design of HLFC leading edge and its damage behaviour against hail impact represents a significant engineering challenge for design and simulation. Different materials are used; carbon fibre composite and micro-perforated titanium to produce adequate suction. Simulation of composite damage mechanisms are complex due to heterogeneity and anisotropy. Additionally, laser drilled titanium simulation has to consider damage micro-mechanisms of the tiny holes of the leading edge.

The uses of current finite element codes are limited in the direct modelling of hail impact against micro-perforated weakened materials. The main obstacles are due to the dependence of the size of micro-perforated holes and localized damage on the mesh element size and alignment. The present study aims to represent a novel application for cohesive elements to model micro-perforated titanium. The implemented model could successfully simulate what it could be called “zipper failure mode”, predicting micro-perforated titanium behaviour. Energetic method is explored, where the breakage line is predefined before the impact. The different advantages and disadvantages are discussed, and the impact of the parameters involved. Correlations between numerical and experimental tests have been carried out. Results demonstrate that the simulated HLFC model is similar to the experimental one giving required confidence for engineers.

REFERENCES

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