REVIEW OF CURRENT RESEARCH TRENDS IN BIRD STRIKE AND HAIL IMPACT SIMULATIONS ON WING LEADING EDGE

Zdobysław Goraj **Kamila Kustroń**

Warsaw University of Technology

Faculty of Power and Aeronautical Engineering

Institute of Aeronautics and Applied Mechanics

goraj@meil.pw.edu.pl kkust@meil.pw.edu.pl

Abstract: Laminated composites have an important application in modern airframes due to extraordinary properties. These properties can be affected by impact results during an operation. Although exterior aircraft structures are exposed to various threats of foreign object damage like hail, runway debris or tire rubber impact, about 90% of all incidences today are reported to be caused by bird strike. Here, the bird strike and hail impact have been studied. The needs to replace parts of expensive certification tests by simulations have been discussed in regarding to bird strike resistance assessment. A review of the research in simulation modelling for wing leading edge has been described. For wing leading edges the certification criteria require that even in case of penetration of the leading edge skin no critical damage may be introduced to the front spar elements or the wing box (wing tank), assuring a continued safe flight and landing after impact. This has to be proven for 4 lb (1.8 kg) birds impacting the wing and 8 lb (3.6 kg) birds impacting the empennage leading edge at operational speed (FAR/JAR/CS 25.571, 25.631).

All issues regarding to modelling an impact process including, impactor, test article and impact phenomenon have been discussed. Differences and similarities while modelling bird strike and hail impact have been described. Different materials to simulate bird and hail during an impact has been discussed. Modelling during an impact using mesh models like Lagrangian, Eulerian, Arbitrary Lagrangian–Eulerian (ALE) as well as meshless particle: Smoothed Particle Hydrodynamics (SPH) have been discussed. Failures that occur in laminated composite structures can be intralaminar and interlaminar. To date a lot of models for impact damages in laminates have been developed with any accuracy. The models can replace real and expensive testing in laminated structures of airframe with some simplifications and assumptions. The research results based on such models can be effective with condition of an assessment the global uncertainty. The global uncertainty analysis is developed as a tool to evaluate the performance of the models. A global sensitivity analysis is defined and used as a complementary tool to find the most important sources of uncertainty. The damage parameters in laminate airframe structures can be predicted by using specialized software. The numerical simulation of bird strike and hail impact on laminate shells can be done and the obtained results from the simulations presented in a form of graphic damage distributions for comparison with diagnostic data.

New model as hybrid model which include advantages and disadvantages of tested models has been proposed.