Low Energy Impact on the Aeronautical Composite

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•**Introduction**: Composite behavior when undergoing to low energy impact has been investigated thorough modelling and simulation computation. We consider the dynamic impact among a small granular material piece and a large composite material body. Really, our investigation will to simulate the aeronautical debris impact similarly when aircraft perform the taxi on the runway or when in the deceleration phase after the landed. Here we consider a CFRP composite panel impacted from with granular particle at low velocity. We develop a finite element analysis initially on the macroscale and successively at microscale where in particular we find inside delamination in according to the experimental results. The proposed analysis has been performed to simulate the behaviour of a real composite panel subject to damage through the COMSOL f.e.m. code. The panel is the covering element of the upper part of a military aircraft. In accordance with other studies, the impact of a granular object has been simulated, whose mass. The following figures shows the most significant results in different impact conditions. These results allowed to build the next model to the microscale.

Macromechanical simulation results
Composite type: CFRP manufactured by Alenia.
Configuration ply : 90/0/45/0/45/0/45/45/0/45/0/45/0/90
Lamina number: 17 more 2 tissue surface layers
Lamina thickness : 250,99 μm (13) 490,147 μm (4)
Fibers diameter 5,289 μm
Impact force: 9 N
Impact area diameter: 4 mm.
Thermal load: 50° C

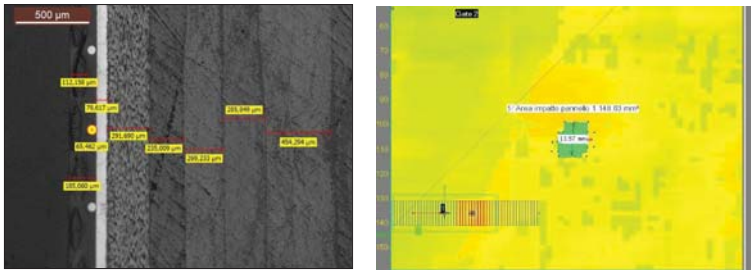

Figure 1 Specimen material property (By Alenia) and Pulse echo results (by C.S.V. Italian Air force)

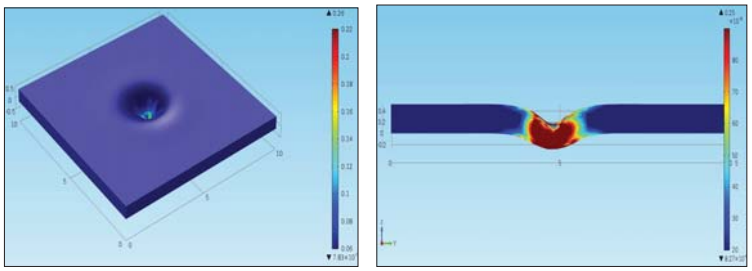

Figure 2 Von Mises stresses a time t= 0 impact

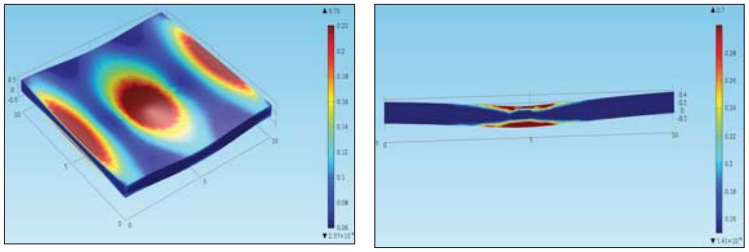

Figure 3 Von Mises stresses a time t= 1s after impact

Micromechanical Simulation Results:

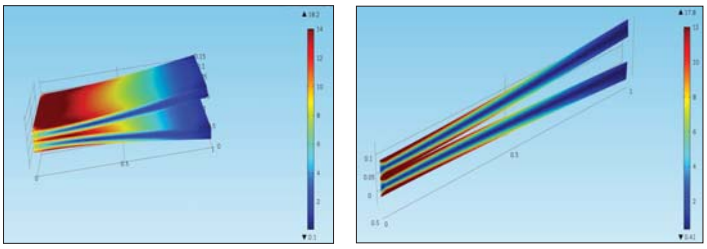

Figure 4. Von Mises stresses (L) and displacement field (R) at 3 g

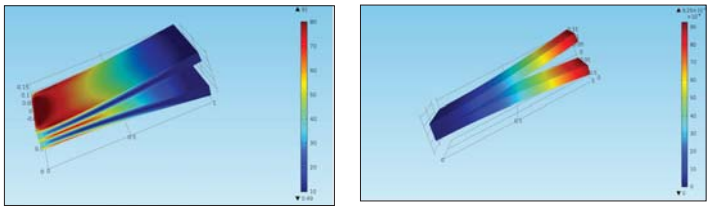

Figure 5. Von Mises stresses (L) and displacement field (R) at 9 g

Thermomechanical analysis results:

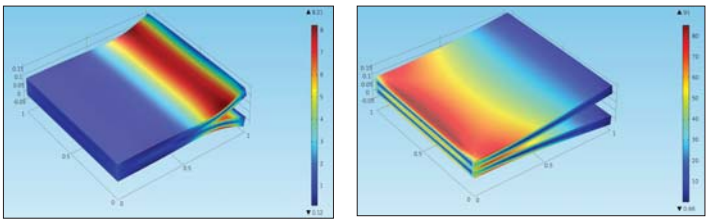

Figure 6. Von Mises stresses (L) and displacement field (R) at 9 g and 50° C

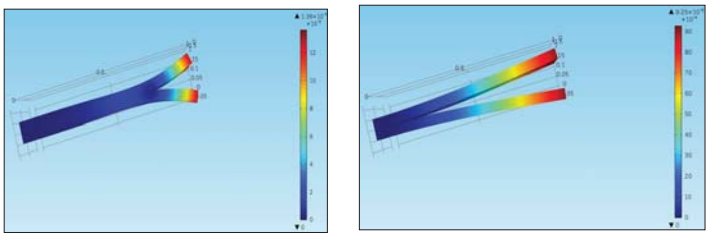

Figure 7. Von Mises stresses (L) and displacement field (R) at 9 g and 50° C

Conclusions: In this study, it was carried out a double investigation, to the macro-scale in order to investigate the overall framework when the impact with one or more parts of granular solids at low speed interacts with the components of the coating panels of aircraft, engaged in the deceleration or acceleration runs. In the micro-scale phase, the investigation focused on the specific loading conditions (thermal) such as to generate the start delamination phases of panel.
The results obtained appear as interesting and useful to further investigations and trials. In fact, in many instances the phenomena of delamination when extending within the composite does not have visibility to control and hence become fracture potential elements catastrophic species when subject to varying loads, as cyclic with the addition of positive or negative thermal actions involving the amendment of the constitutive response of the material (creep or fragility).

References

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