High velocity impact of composite aircraft structures

Results in Brief

Simulated aircraft material testing

The quest for lighter and therefore faster aircrafts, without sacrificing any of the safety standards, has resulted in an intense research effort in the field of materials science. Innovative fibre reinforced composite materials are currently being used by the European multi-euro aerospace industry. Substantial improvement of simulation techniques for materials testing has been an urgent requirement by this industry. The current project has met successfully such a demand.

Composite materials, i.e. materials resulting from combination of other materials, have been used for centuries. Straw for example has been used to strengthen mud bricks. This also serves as an example of fibre reinforced composite materials, where straws are the fibres and the mud is the softer, more ductile, encapsulating the fibres matrix. Nowadays composite materials made out of plastic and reinforced with carbon fibres are widely used in the aerospace industry due to their lightness in connection with their good impact properties.
Impact properties of reinforced composite materials are of critical importance for aircraft safety. Since the materials are used for the construction of wings, jet engines and fuselage structures, high velocity impacts from bird collisions, runway debris or burst tyres pose serious aircraft safety issues. The quite recent Concorde accident over Paris testifies to the above.

High Velocity Impact of Composite Aircraft Structures (HICAS) is the acronym of a basic research project, launched by a consortium of European airframe and aero engines manufacturers, research institutes and software specialists. The project partners have developed a methodology for simulating numerically and predicting the response of composite aircraft components and structures to high velocity impacts. Specifically, procedures to measure mechanical properties of selected aircraft materials under large strain, high strain rate have been developed. Materials constitutive laws and failure models for advanced unidirectional and fabric composites under velocity impact of up to 400m/s have also been developed and implemented into three already commercially available finite element impact and crash codes. Simulating the laboratory high strain rate tests and high velocity impact tests on idealised composite structures has additionally validated the finite element methodology.

Availability of validated simulation tools is essential for the aircraft industry since use of these tools result in a substantial reduction of development costs and accelerates the development cycle for new materials, giving European industries a head start in fierce international competition. Moreover, composite materials are now also used in automotive structures and the failure modelling capabilities of the developed algorithms are directly applicable to this much greater industrial sector with obvious and immediate economic consequences.

More information about the code development work as also conference papers and workshops held can be found at the HICAS website.
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