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Method development for full aircraft crash simulation at different levels of modeling detail

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Abstract

For a climate-neutral future the aviation industry will have to transform to new aircraft designs and propulsion systems in the coming decades. Depending on the required aircraft range and size, future aircraft will be powered by hybrid-electric or full electric propulsion systems using synthetic fuels, liquid hydrogen or batteries. Non-traditional aircraft configurations will have to be developed for these novel propulsion systems leading to a demand on research, also for crashworthiness.

Crashworthiness of transport category airplanes in civil aviation is subjected to safety standards which are specified by the certification authorities (e.g. FAA 14 CFR Part 25, EASA CS-25). These safety standards are based on existing data from accident research and experimental crash tests on aircraft components, aircraft fuselage sections or even full aircraft. However, such large-scale crash tests are time and cost intensive which limits their realization in the development of new aircraft concepts. With regard to the novel transport aircraft designs for climate-neutral aviation, a safe integration of large-volume energy storages in the airframe structure will be a key element and the subject of research work in the coming years. Investigations on crash safety for such non-traditional aircraft designs requires an assessment at the full-aircraft level using extensive support by numerical simulation. However, full-scale aircraft crash analyses require the development of validated simulation methods.

The development of new model generation tools and analysis methods as well as the available computer resources enable the analysis of large high-fidelity finite element models today. The German Aerospace Center (DLR) Institute of Structures and Design (BT) develops simulation methods for full aircraft crash analysis, e.g. crash scenarios which typically occur during the take-off or landing phase. This development of full aircraft crash analysis using numerical methods is divided into a generic and a specific phase. In the generic phase, model generation tools and simulation methods are developed and tested based on a generic aircraft design. In the specific phase, the developed simulation methods are evaluated and validated on the basis of available test data. The structural modeling of low- and high-fidelity fuselage sections and full aircraft is carried out with the process chain tool PANDORA (Parametric Numerical Design and Optimization Routines for Aircraft) developed at DLR.

This presentation shows the current status of the research work at DLR on full aircraft crash analysis. In the generic phase, first full aircraft simulation analyses using low- and high-fidelity simulation models were carried out which gave initial insights in crash kinematics and expected passenger injury levels. In the specific phase, simulation methods for the crash analysis of fuselage sections were evaluated on the basis of two Fokker F28 fuselage section drop tests previously performed by FAA and NASA.

References

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