DEVELOPMENT OF A MULTIDISCIPLINARY PROCESS CHAIN FOR THE PRELIMINARY DESIGN OF AIRCRAFT STRUCTURES

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SUMMARY

In the Preliminary Design Phase of an aircraft development trade studies are conducted to find an optimized design for an aircraft fuselage. Therefore the generation of several different models is required. But still, the generation and adaption of fine FE models is a time-consuming task which in turn can prevent the conduction of trade studies with high fidelity tools and subsequently leading to cost intensive redesign activities in the detailed design phase.

Based on the standardized aircraft description format CPACS, developed at the German Aerospace Centre (DLR), a fully parameterized fuselage modelling tool was developed to generate global aircraft FE models for static sizing using shell elements for the skin and elastic beam elements for reinforcement and the floor structures with all relevant boundary conditions, e.g. constraints, materials, loads. This modelling tool runs completely automatically without any user interaction. Recently, a wing model and the Centre Wing Box were added to achieve a realistic introduction of the aerodynamic loads into the pressurized fuselage.

For a subsequent investigation of the crash behaviour this model can be refined locally in the expected impact regions by the use of fine shell element representation to account for energy absorption methods - plasticity in case of a metallic or damage introduction in case of composite construction. Likewise some other regions may be modelled using a fine shell element mesh, e.g. the door surround structure which must not deform plastically in survivable crash load cases to assure its function as an emergency exit.

In this paper the process chain and its data processing methods will be presented in detail. The constituent codes and their interactions will be explained showing the versatile capabilities. Moreover several modelling approaches and crash computation applications will be presented ranging from drop tests with a pure vertical speed, which are representative for numerical simulations performed in certification loops, up to full scale AC crash simulations, e.g. ditching or Nose Landing Gear failure. In addition, the time required for generating models will be evaluated regarding the potential of the process chain to conduct parametric studies and investigate different aircraft configurations.

Concluding this paper a short outlook will be given showing possible further development steps and discussing potential future applications.