# Multidisciplinary optimisation of an aircraft fuselage with static and crash requirements

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The application of composite materials in aerospace industry increased within the last years due to great potential in lightweight design as well as new innovative manufacturing processes. Within recently developed civil aircrafts also the fuselage, the PAX and the cargo floor mainly consists of composite materials. For these areas, in addition to the general static loading, also crash requirements have to be fulfilled. Due to the brittle failure behaviour of composites, compared to the ductile behaviour of metallic structures, crash requirements forces to take additional measures, for example the equipment with crash absorbing elements. In order to find a global optimum for the weight of the fuselage a multidisciplinary optimisation was performed. For both disciplines an own FE-model, adapted to a specific solver, was used.

The static FE model was build up for the Altair solver OptiStruct. A basic model of the fuselage was equipped with tensile absorber elements and additional parts to transfer the absorber forces into the fuselage structure. Composite failure criteria and buckling constraints have been implemented in order to constrain the model. By variation of the composite layups and thicknesses, a static load related optimum could be found.

In parallel a dynamic crash model was developed for the Abaqus explicit solver. The specific challenge for this model was a correct reproduction of the crash failure despite a short calculation time which is essential for a front-end optimisation process. Further on a specific indicator for the efficiency of the absorber elements has been introduced. Using Altair HyperStudy DOE (design of experiment) runs have been carried out by varying the composite thicknesses and the load level of the absorber and finally a response surface could be defined. Based on this response surface, the optimiser of HyperStudy could find configurations with maximum energy absorption and minimum weight levels.

Finally both solving processes have been coupled using Hypestudy in order to find an optimum considering composite failure requirements under static loads and ensuring a given minimum energy absorption level for the crash load case. It could be shown that a real multidisciplinary optimisation gains better results than a sequential sizing process for static and dynamic requirements.