# Hybrid composite materials for highly an integrated energy-absorbing concept for aircraft cabin interior

**Authors:** Dipl.-Ing. M. Pein[a], Prof. Dr.-Ing. D. Krause[a], Dipl.-Ing. S. Heimbs[b], Dr.-Ing. P. Middendorf[c],

[a] Hamburg University of Technology,
[b] EADS Corporate Research Centre Germany, Hamburg
[c] EADS Corporate Research Centre Germany, Ottobrunn

Abstract: *An innovative concept for investigations for new approaches for the passive safety of aircraft cabin interior in commercial aircrafts is presented. The concept comprises fibre reinforced plastics as an energy absorbing material allowing a light weight, but leading to challenges in design and simulation. Because of the complex failure modes, intensive material testing was conducted, creating a knowledge-base for design, including design-guidelines. To provide further information for design, Finite-Element-Analysis with LS-Dyna was conducted, showing that the simulation of the concept has to consider non-physical input, due to the complicated failure mode, which is discussed based on the used material model. The presented information is the output of a joint research project between Airbus Germany, EADS and the Hamburg University of Technology.*

The aim of the development of lightweight energy absorbing support structures (force limiters) for A/C cabins is to provide a safe area for passengers during hard landing. For example, the overhead stowage compartments (OHSC, hatracks) inside the A/C cabin are subjected to high loads during a survivable crash scenario. To prevent the detachment of the hatracks from the primary A/C structure force-limiting support structures can be used, ensuring a structural integrity of the hatrack and the A/C structure up to a certain level, depending on the energies involved.

Because commercially available solutions for force-limiters are failing the specific aircraft boundary conditions, a joint research project between Airbus Germany, EADS and the University of Hamburg was conducted, funded by the Department of Economy and Labour of Hamburg.

Today the applicable design rules (e.g. FAR 25.561) refer to static accelerations which are used to calculate the forces inside the connecting support structures. Due to the short duration of a crash, these design rules do not necessarily represent the transient nature of the acting forces and accelerations, so an approach towards dynamic load cases, as used for the certification of A/C seats (e.g. SAE AS 8049), was investigated. Since the load varies with time, force-limiters can be used to lessen the maximum stress in A/C structures and hatracks. Therefore the development is aiming towards force limiting supports, which are capable of absorbing high amounts of energy but light weight, thus leading inevitably to the design of innovative supports / attachments, which comprise new energy-absorbing materials.

## Energy-absorbing concept

During the project more than 10 different energy absorbing materials with different support concepts ( [1], [2]) were analysed according to the defined boundary conditions, showing promising results but requiring a bigger design space than normal supports. Based on the patent application publication DE 199 26 085 [3]one concept was found showing a high potential for implementation as a z-axis hatrack support, Fig. 1.

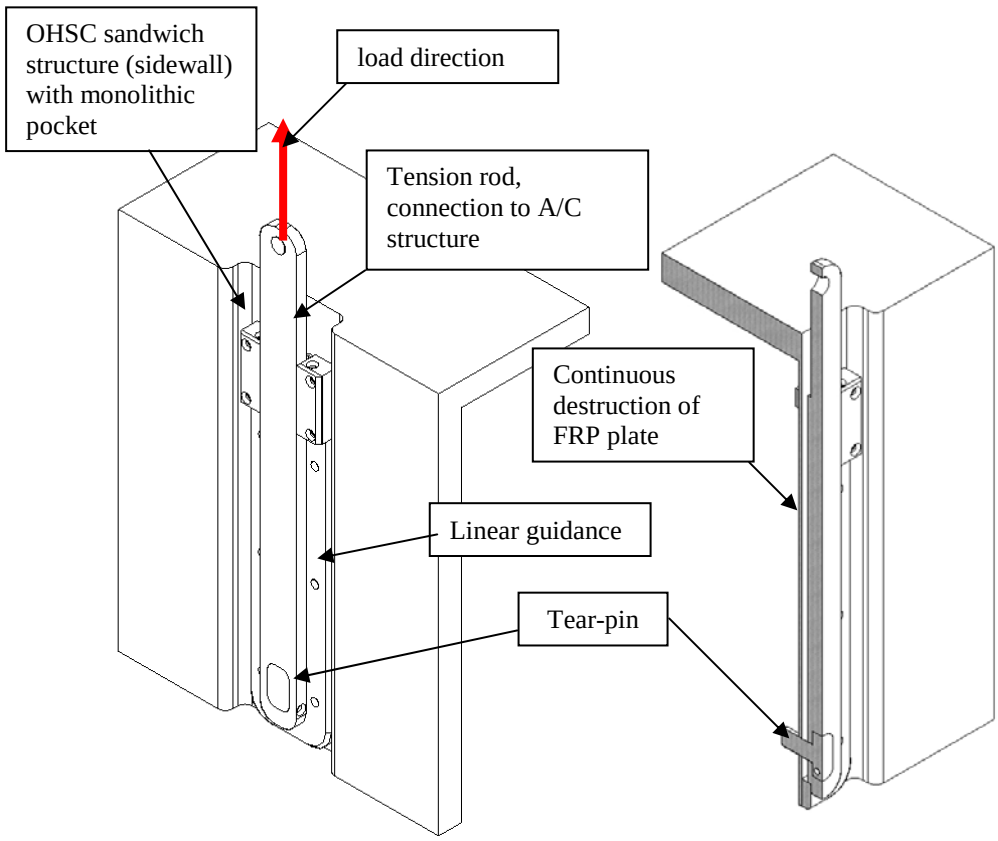


**Fig. 1: Pin/plate absorbing concept with part of an OHSC sandwich structure**

The design of the concept will be discussed in detail giving information about the materials, especially fibre orientations and derived design rules, as well as the results of the simulation of the concept in the finite element code LS-Dyna ( [4], [5]) ( Fig. 2).

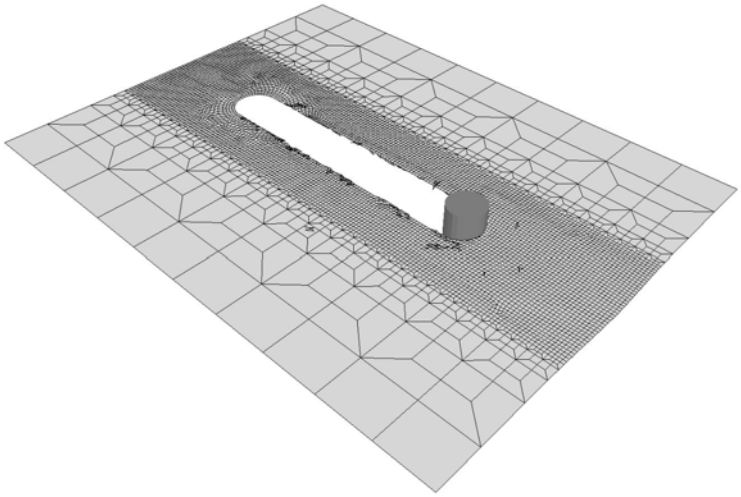

**Fig. 2: LS-Dyna-Model of the absorber concept**

[1] M. Pein, V. Laukart, D. G. Feldmann, D. Krause: *Concepts for energy absorbing support structures and appropriate materials*. ICAS 2006, Hamburg, September 3-8, 2006.

[2] M. Pein, D. Krause: *Leitfaden zur Entwicklung von Leichtbauenergieabsorbern in Flugzeugkabinen.* 17. Symposium „Design for X“, Neukirchen, October 12-13, 2006 (in german).

[3] W. Extra: *Mechanische Absorptionsvorrichtung*, Offenlegungsschrift DE 199 26 085, Deutsches Patent- und Markenamt, 2000 (no patent assigned, in german).

[4] K. Schweizerhof, T. Münz, K. Weimar, T. Rottner: *Improving and testing the composite materials in LS-DYNA for crash problems - a critical survey*. CADFEM GmbH Grafing, 1998.

[5] M. Hörmann, M. Wacker: Simulation of the crash performance of crash boxes based on ad-vanced thermoplastic composite. 5th Eur. LS-DYNA Users Conf., Birmingham, May 25-26, 2005.