Composite material characterisation: A best practice methodology to accelerate early development

The collaborative project between Forward Engineering GmbH, Hexion GmbH and Zoltek Corporation is aimed at decreasing the entrance barrier into composite structure development for the automotive industry. A standardized process of material characterisation and material card generation for FEA was established. The process is based on industry standard CFRP materials and follows a modular approach that helps to reduce complexity, testing cost and development lead times.

Increasing demands on composite structures, mainly from crash load cases, require material properties beyond linear elastic values. Additional material tests for non-linear post-failure loadcases have to be considered and suitable material models established.

Parallel development paths

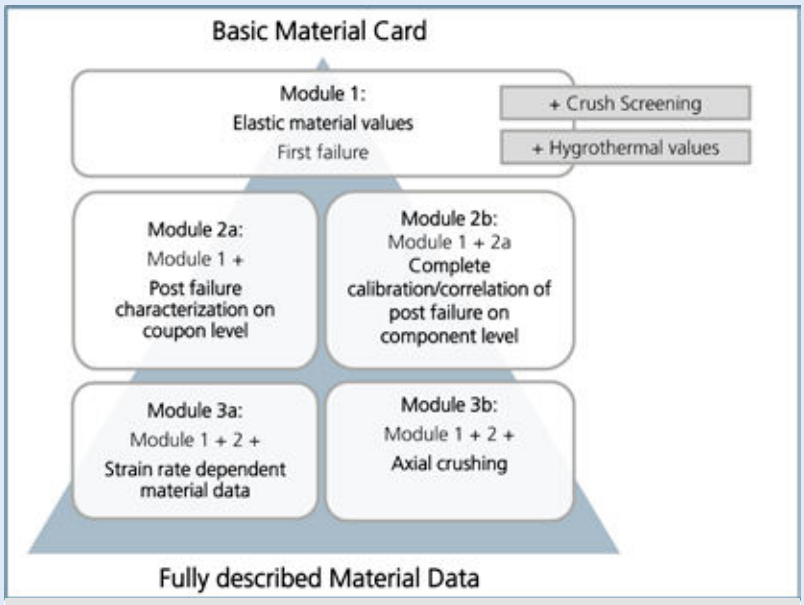
The project partners propose a guideline for standardized material testing that follows two main objectives.

- Accelerating early development phases and decision processes by parallelisation of design and FEA verification
- Cost reduction using best practice methodology

By additionally providing a ready to use advanced post failure material card (LS-Dyna, MAT58 and MAT261 material models) to our customers, security in early development phases can be increased. The example material card was created using well established and cost optimized materials for mass production by Hexion and Zoltek (see table below) to form a common toolbox of materials.

Materials	
Fiber	Zoltek™ UD300 UD-NCF Zoltek™ PX 35 Fiber
Resin System	Advanced Resin System EPIKOTE™ Resin TRAC 06170 EPIKURE™ Curing Agent TRAC 06170 HELOXY™ Additive TRAC 06805 for RTM and WCM

Materials used for creating an example material card



Overview of best practice material characterisation approach

Typically, materials and testing methods have to be adapted to meet the specific requirements composite structures to develop.

First insights into the general suitability of the material, especially for energy absorption use cases, can be obtained by running a crush screening early on. This screening is a recommended tool to support material decisions at low cost but with a considerable amount of useful data e.g. specific energy absorption rate (SEA) and crash stability behavior.

Module 1 is the foundation of the testing program and provides linear elastic material properties for basic calculations. If there is a need for post-failure assessment, Module 2 has to be considered, whereby Module 2a is based on coupon-level hardware tests and describes the minimum requirement to establish a post-failure material card for crash modelling. Module 2b adds post-failure testing on part level to further refine the material models and add interactions between failure modes.

If needed, the simulation forecast quality can be increased further with module 3.

The presented best practice method will be expanded with further material combinations and production technologies.

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