Today's Challenges in Crash Simulation

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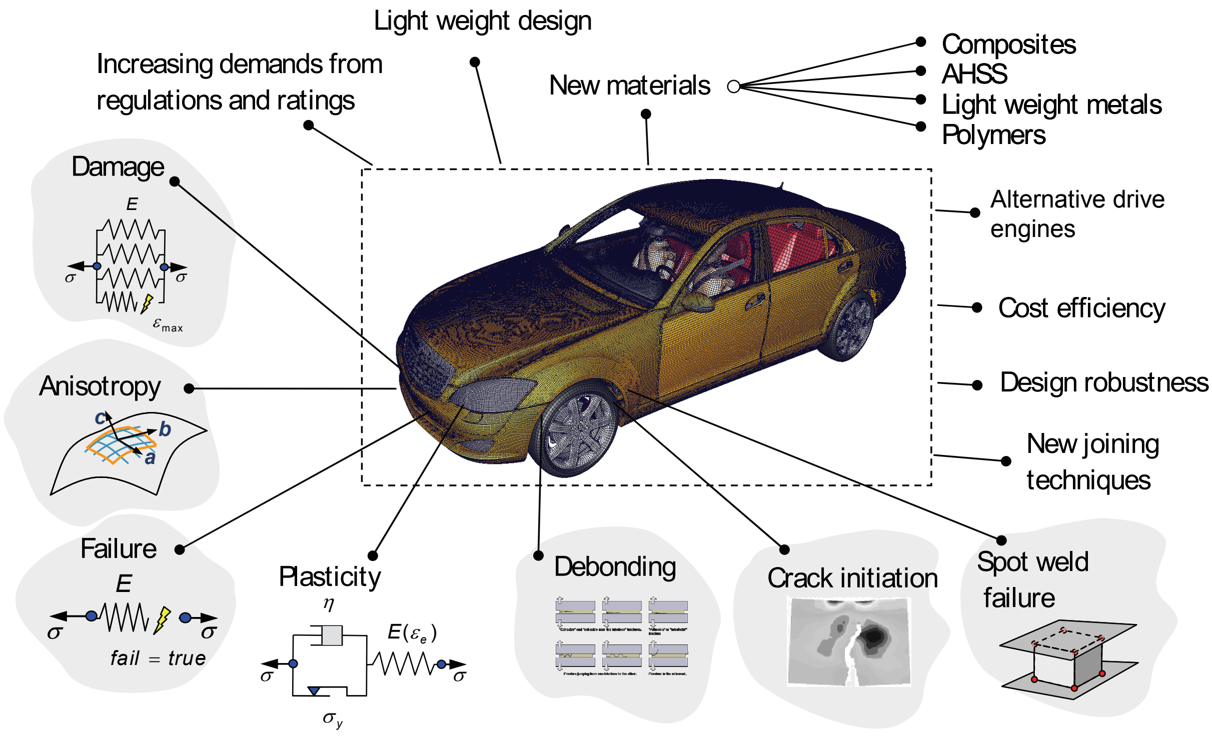
Summary:

Crashworthiness simulations of car body structures are an important part of the CAE development chain for car design. In recent years, the requirements on passive safety of cars have grown to high standards, leading to a permanent demand on an increase in simulation accuracy. Additionally, demands on fuel efficiency and CO_2-reduction are confronting the car body designers with the need of weight reduction to an immense effort.

One way to achieve light-weight structures is to replace conventional body-in-white materials, like conventional deep-draw steels, by more sophisticated materials. Besides of using metals such as advanced high strength steel grades, aluminium or magnesium alloys, the use of composite materials and hybrid metal-polymeric structural components is increasing in the automotive industry.



Since these materials often show rather complex mechanical behaviour, it is of great importance to precisely predict failure under crash loading conditions. Additionally, especially for metals it seems more and more evident that the before going treatment of the material through the manufacturing process chain significantly influences crash performance of the respective material. Here, an emphasis has been laid on identification of damage parameters and a comparison of relevant damage accumulation models and theories from forming to crash simulation. Special attention was paid to existing differences regarding stress states between forming and crash loading, to clarify differences in failure prediction models respectively.

The numerical simulation of structural parts made from plastics is becoming increasingly important nowadays. The fact that almost any structural requirement can be combined in a lightweight, durable and cost effective structure is the driving force behind their widespread application. More and more structurally relevant parts are being constructed and manufactured from plastics. This, on the other hand, drives the demand for reliable and robust methods to design such parts and to predict their structural behaviour sufficiently close to reality. The key ingredients that need to be available are verified, calibrated and validated constitutive models for any family of polymeric materials. This holds true not only for crashworthiness applications – which are the main focus of this contribution - but for any other field of application, too.

The application of new materials in body-in-white structures is leading to higher requirements in the joining techniques, too. One example is the conventional spot welding of press hardened steels, where the heat affected zone loses its properties that were achieved by heat treatment. This local change in properties has to be taken into account for a sufficiently precise description of spot weld failure mechanisms. The actual development here is to consider the amount of fracture energy that is dissipated during spot weld failure. This seems to play an important role even regarding the global behaviour of structural parts in full car crash simulations.

Finally, it will be shown that for ensuring a maximum in predictive performance, advanced modelling techniques have to be used simultaneously for all topics described above in order to capture possible interactions of the phenomena described above.

Literature

[1] F. Neukamm, M. Feucht, A. Haufe: „New developments for coupled forming and crash analysis including damage and failure” in: Proc.of Forming Technology Forum 2009, ETH Zürich, Switzerland

[2] P. Du Bois, M. Feucht, A. Haufe, S. Kolling ”An Overview of ductile damage models in LS-DYNA”. In Proc.of 6th LSDYNA Forum, Frankenthal, 2007.

[3] A. Haufe, M. Feucht “Aktuelle Trends bei der Modellierung von Schweißpunktverbindungen in der Crash Simulation mit LS-DYNA“ in Proc. of 5th CrashMAT Workshop, Freiburg, 2009.