From aluminium extrusions and high-pressure die castings to batteries: mechanical challenges in electric vehicle safety

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The rapid transition toward battery electric vehicles (BEVs) has intensified the need for lightweight structural solutions that meet increasingly demanding safety requirements. This presentation addresses mechanical challenges associated with electric vehicle safety, spanning aluminium extrusions, high-pressure die castings (HPDC), and lithium-ion battery systems.

After a brief overview of the structural architecture of BEVs and safety considerations related to lithium-ion batteries, the role of aluminium extruded crash components is discussed. Particular attention is given to the mechanical response of extruded profiles under complex loading conditions, including side loading and multi-axial deformation, where microstructural features such as texture, particle distributions, and damage mechanisms strongly influence failure and energy absorption.

The discussion then moves to high-pressure die cast aluminium components, increasingly adopted as cost-effective large structural parts. Experimental observations reveal pronounced stochastic fracture behavior linked to casting defects, porosity, and microstructural heterogeneity. These features pose significant challenges for predictive modelling, especially with respect to crack initiation and propagation. Strategies for bridging experimental characterization and computational modelling will be discussed, including approaches to account for variability and damage evolution.

The presentation concludes with mechanical aspects of battery systems under abuse loading. Experimental observations from mechanical abuse tests highlight the complex coupling between structural deformation and battery integrity. Modelling challenges related to multi-physics behaviour, material uncertainty, and failure prediction are outlined, together with perspectives on integrated structural–battery simulations for improved vehicle safety.

About the speaker:

David Morin is Associate Professor in Structural Engineering at the Norwegian University of Science and Technology (NTNU) and a member of SIMLab. He obtained his PhD from the University of Valenciennes (France) in 2010 and subsequently joined NTNU. His research lies in computational solid mechanics, focusing on the modelling of materials, joints, and structures subjected to large strains and impact loading. From a materials perspective, he places particular emphasis on ductile fracture of metallic materials and lightweight aluminium structures. He develops constitutive and multiscale models that are closely integrated with experimental investigations, ranging from mechanical testing to detailed microstructural characterization.