Crash Simulation of Public Transport Vehicle Traction Battery

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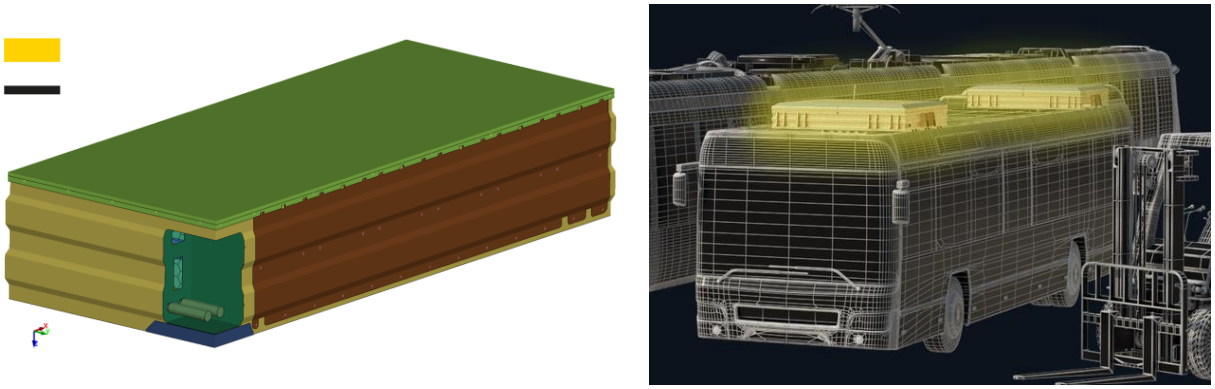
Nowadays, lithium-ion batteries are considered as most efficient source of power for electric vehicles (EVs). With the increasing utilization of EVs, the requirements for higher performance, lower weight and improved safety also growing. These demands can be fulfilled by an improved traction battery design, which consists of decreased battery frame mass or higher number of battery cells. However, with these improvements come several negative aspects, such as higher risk of battery frame intrusion or reduction of space between the cells. Due to these factors, the risk of battery damage is rising and it is crucial to predict and better understand the behaviour of the battery cells during critical situations, such as vehicle crash.

Ansys LS-DYNA is a useful tool for the evaluation of battery cells during abusive scenarios. It offers the creation of multi-physics model that could predict coupled mechanical, electrical and thermal responses. Electro-chemical behaviour of cell is described by equivalent (Randels) circuit, which is incorporated in homogenized BATMAC model used in the paper. This simplified model is sufficient for the assessment of battery cell response to short circuit, which can be triggered by mechanical damage (penetration, deformation), overheating or high current flow. Depending on the state of charge (SOC), a short circuit can lead to uncontrollable, self-heating state called thermal runaway. This state poses the greatest safety risk for Li-ion batteries. To calibrate and optimize the numerical model, various mechanical, thermal and electrical tests need to be conducted.

The paper focuses on crash simulation of public transport vehicle traction battery with prismatic cells. This work is part of comprehensive project that consists of development of robust early warning battery failure system that would enable the fire rescue service to distinguish a non-hazardous technical fault from a critical accident in time. Another crucial part of the project is the design of a self-extinguishing and cooling system for the battery pack. These designs aim to improve safety and extend lifetime of the new traction battery, the manufacturing of which is also an output of the project. Project is in progress in cooperation with CTU in Prague, NANO POWER a.s. and TÜV SÜD Czech s.r.o.



a) b)

Fig.1: a) FE Model of battery pack, b) public transport bus traction battery placement.