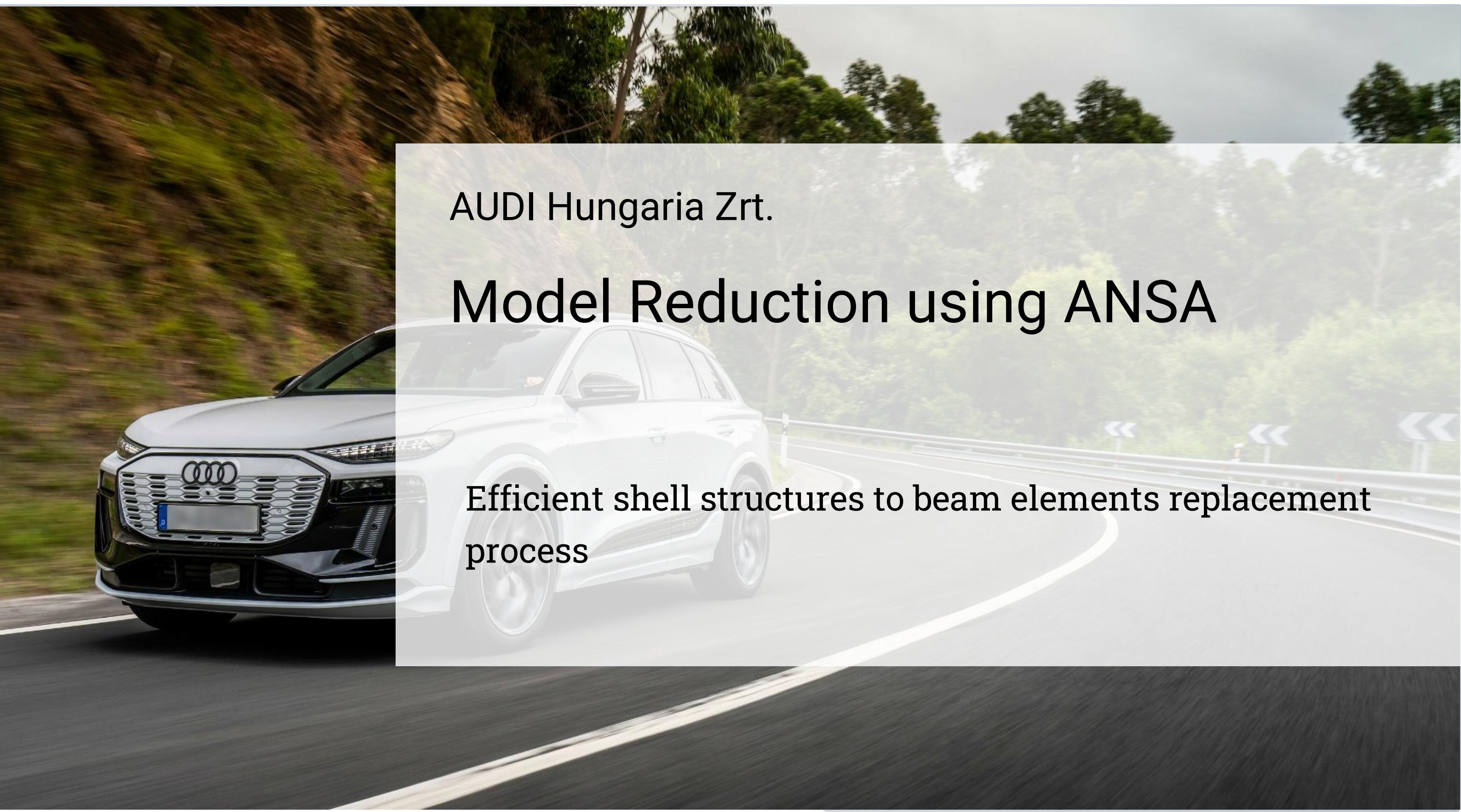


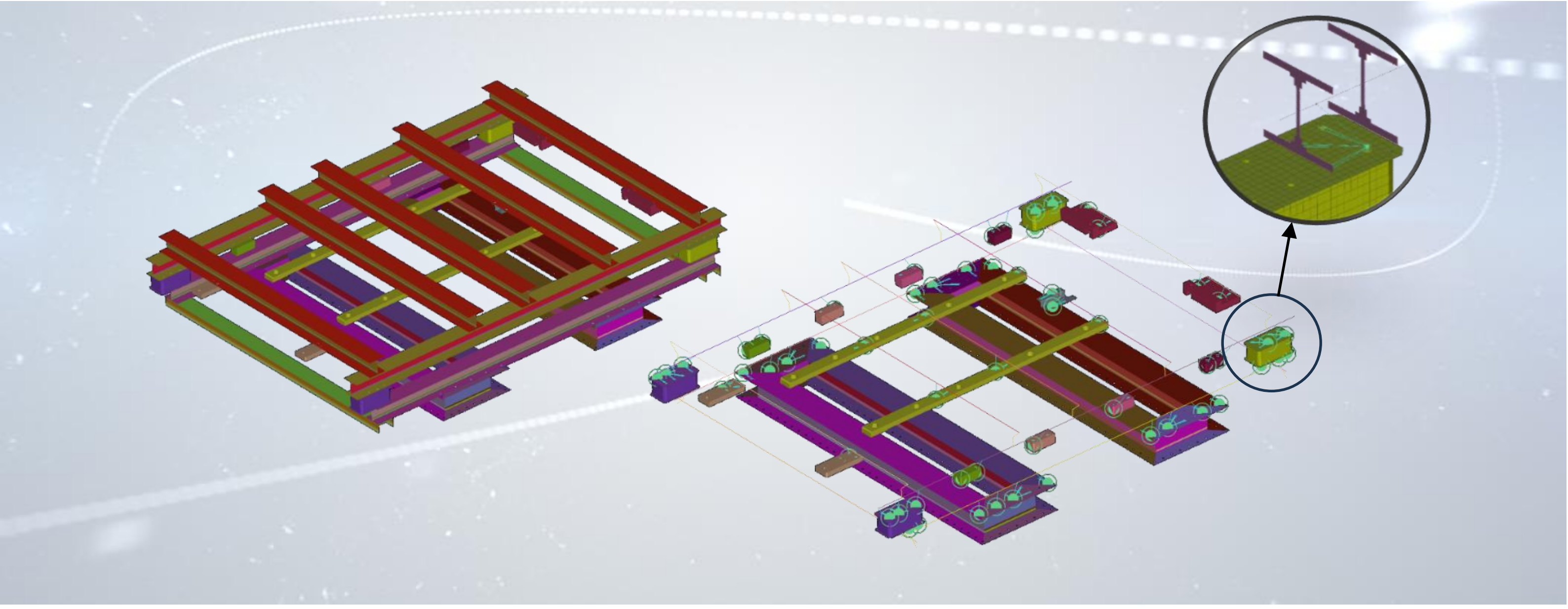
AUDI Hungaria Zrt.

Model Reduction using ANSA

Efficient shell structures to beam elements replacement process

Model reduction techniques play a pivotal role in the efficient simulation and optimization of complex mechanical systems. By replacing detailed shell structures with simplified beam elements, engineers can significantly reduce computational time, especially during iterative design and optimization processes involving beam-like components. Despite their advantages, these techniques are challenging—particularly in accurately modifying shell element beam profiles to preserve structural fidelity. This complexity becomes especially relevant in the context of battery electric vehicles (BEVs), where the high-voltage battery system constitutes a large and mechanically critical component. To ensure reliable performance under crash and fatigue conditions, the battery must be tested within a dedicated test frame that replicates the vehicle’s dynamic behavior. Integrating model reduction strategies into this framework allows for a more efficient yet robust evaluation of the battery’s mechanical integrity, balancing computational efficiency with physical accuracy.

> “Ensuring mechanical durability is crucial in early component development. The reliability of virtual tests depends on the test frame’s quality, which we improved using ANSA’s beamifying tools—saving significant development time”
>
> Gergely Markó
> CAE Engineer
> AUDI Hungaria Zrt.



Challenge

The reduction process becomes particularly complex when both the creation of beam elements and the calculation of cross-sectional properties are required. Especially when different tools are required for the process. Key challenges include:

- Streamlining the reduction process to be fast and user-friendly
- Efficiently connecting newly created beams to each other and to the remaining structure
- Ensuring the natural frequencies of the beam model closely match those of the original shell model
- Facilitating cost-effective modification of beam cross sections

Approach

To address these challenges, we developed a streamlined process leveraging ANSA's existing functionalities, complemented by a custom script to manage the assembly between beam elements and the remaining structure. Key steps of the process include:

- Utilizing ANSA's advanced Edit Mesh functionality to prepare areas for beam substitution. This involves simplifying features such as holes, ribs, and other inconsistencies that may affect cross-sectional accuracy.
- Automatically generate ANSA Assembly Points to mark and manage the interface between substituted and remaining parts.
- Exploiting ANSA's Beamify tool to rapidly replace shell structures with beam elements, including automatic calculation and assignment of cross-sectional properties.
- Using a custom script to precisely connect the newly created beams with the remaining shell structures via the defined Assembly Points.
- Finalizing the model by connecting any unlinked beam chains using dedicated ANSA functionality.

During the substitution process in step three, ANSA transfers mechanical properties such as stiffness and inertia to the beam elements. Cross-sectional properties are calculated with ANSA's cross-section solver and assigned to the respective solver cards, enabling parameterization for optimization.

Results

In collaboration with AUDI, a unique and efficient process was developed to resolve the primary challenges encountered during model reduction. This innovative substitution approach was implemented exclusively using ANSA tools, leveraging a fast, reliable, and precise methodology, streamlining the optimization workflow without compromising structural fidelity.

Initially, the process of optimizing the test frame required 20–30% more time due to the complexity of the shell structure. This overhead was significantly reduced by converting the shell model into a simplified beam representation and performing the optimization steps on the reduced model. Through careful tuning of the beam connections, the simplified model could achieve satisfactory accuracy for development purposes.