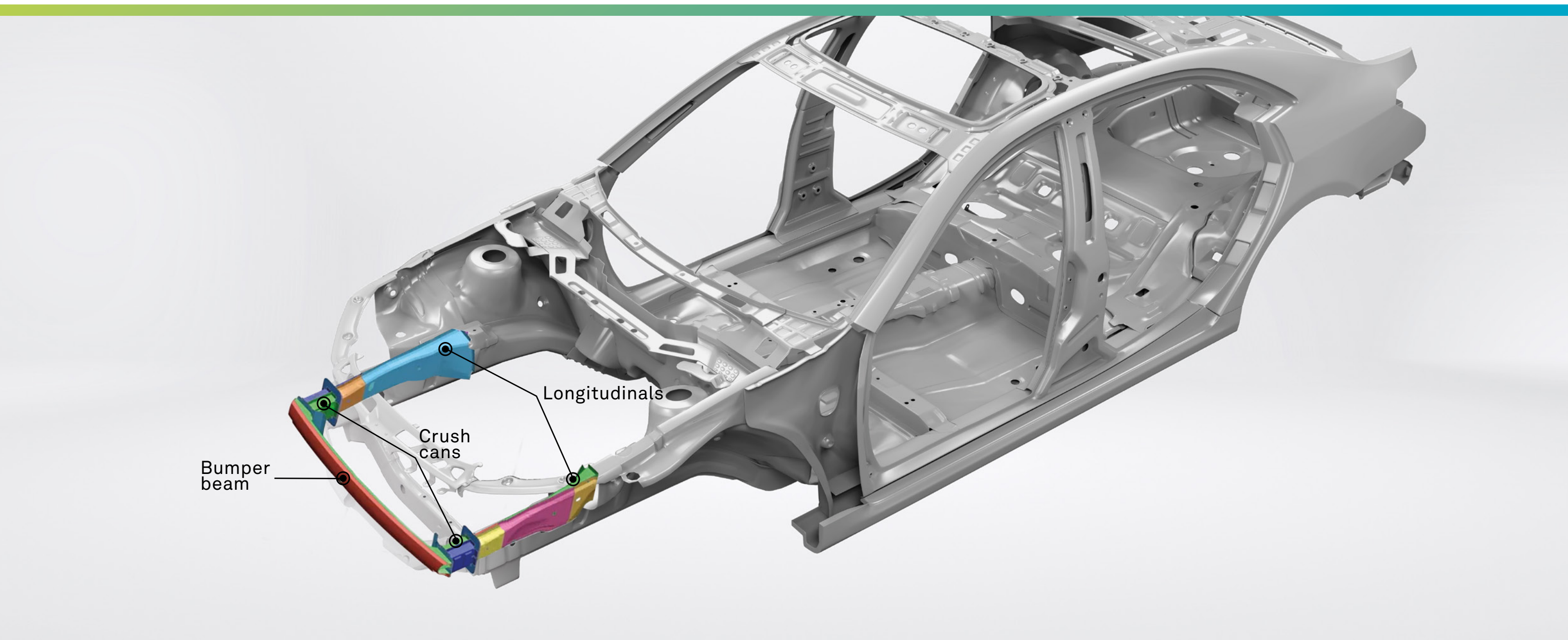
Case study

Automotive accidents of tomorrow: exploration of innovative crash structure design trends

Coventry University – United Kingdom



ODYSSEE CAE helps Coventry University analyse new crash structure design effectiveness.

The Institute for Future Transport and Cities at Coventry University has 140 research staff and 175 post-graduate research students. They have research projects funded through industry and funding bodies such as EPSRC, Innovate UK, and EC.

The research performed at the Institute for Future Transport and Cities in Coventry University is at the forefront of mobility innovation in a rapidly changing technology-enabled world. The multi-disciplinary team enabled by strong internal and external networks develops knowledge through cutting-edge applied research.

The Institute for Future Transport Cities is located at the National Transport Design Centre in Coventry, UK.

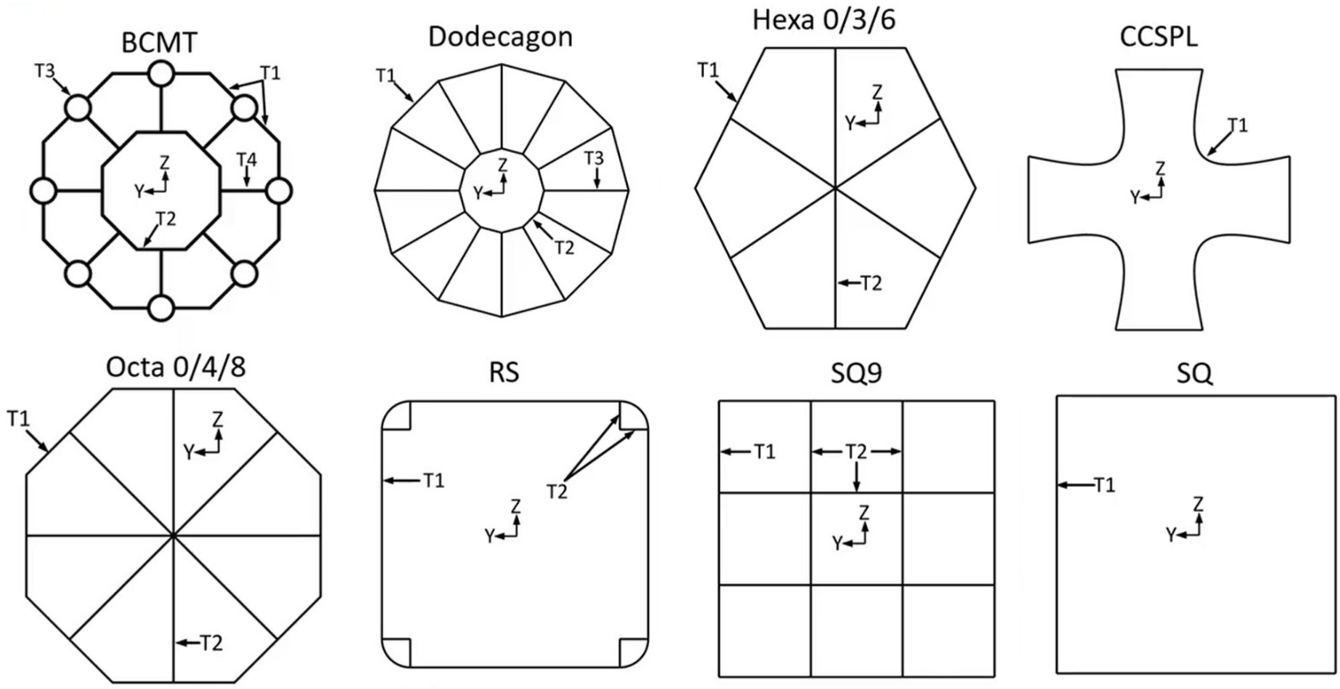


Fig 1: The cross-sections of the studied crush can design

Challenge

The crush structure is composed of the crush cans and the backup longitudinals. This structure is to limit the forces and accelerations felt by the occupant. The typical design of the crush can is a square or a double U cross-section. There are new innovative structure designs with multi-cell, multi-angle, functional materials, and grading. These newer designs do not offer a way to equally compare their effectiveness, as the designs vary in length, impact type, impact velocity, and performance metrics.

Coventry University's Institute for Future Transport and Cities wanted to compare the efficiency and effectiveness of the innovative design trends for the crash structure. They selected 12 different geometries representing the different trends in multi-cell and multi-angle structures. Each design was then optimised with thickness and the optimal taper gradient to represent the best of each design. The testing of each optimised design was conducted to reveal the efficiency, maximum longitudinal backup structure loading, and maximum acceleration.

> **ODYSSEE CAE provided a straightforward solution to a very large optimisation study including time/history information."**
>
> **Jesper Christensen,**
> Associate Professor

Solution

ODYSSEE CAE created reduced-order models (ROM) for each of the new designs and was able to evaluate them for each scenario. The automated script within ODYSSEE CAE allowed for only 1500 FEM simulations for the entire study instead of generally using 15000 through FEM for non-linear optimisations. The ROM produced by ODYSSEE CAE keeps an accurate time history curve that can be compared to the FEM simulations, a feature that is not possible with a response surface method. This feature was critical for understanding the initial instability of one design that led to vastly different results between the ROM prediction and the FEM simulation.

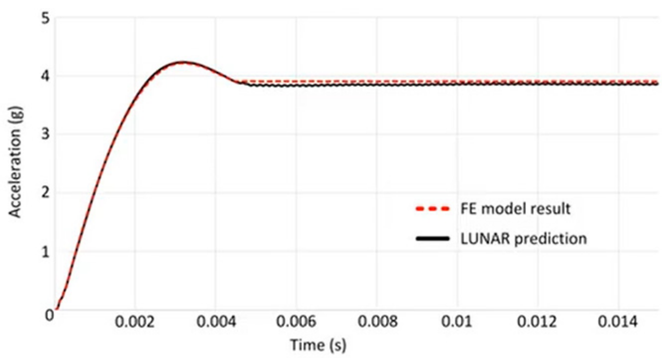


Fig 2: The ODYSSEE CAE (Lunar) prediction compared to FEM validation curve for acceleration

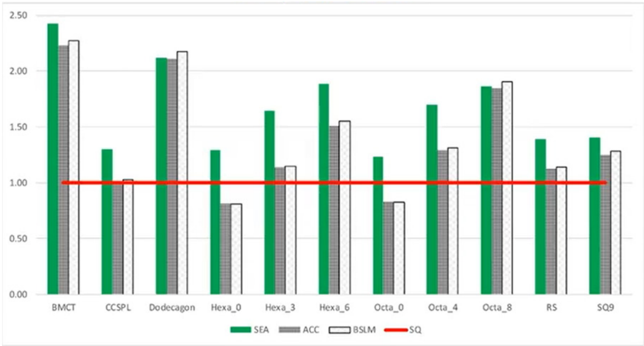


Fig 3: Comparison of the different crush structures design to the standard square design (Red line)

Results

ODYSSEE CAE uniquely allowed this study to critically evaluate the new crash structure designs to happen through creating ROMs. The optimisation time was manageable due to using a magnitude less FEM simulation. ODYSSEE CAE predictions were accurate to FEM simulations, with the average error of each design and scenario within 5%.

> **Optimisation results demonstrated inherent issues with certain designs which was not previously clear."**
>
> **Jesper Christensen,**
> Associate Professor

The worst predictions for the designs and scenarios were generally within 10% of the FEM values. The ability to see the time history curve allowed changing parts of the ROM to account for the initial instability seen in the FEM. The results of the study show that new designs varied in efficiency with the hexagon, without internal braces, being a promising candidate. With the help of ODYSSEE CAE optimisation, the new designs' efficiency and performance in the various scenarios were made clear.

Key highlights
Product: ODYSSEE CAE
Industry: Automotive
Benefits: • ODYSSEE CAE AI/ML helps Coventry University explore the potential of innovative crash structure designs.

Hexagon is a global leader in digital reality solutions, combining sensor, software and autonomous technologies. We are putting data to work to boost efficiency, productivity, quality and safety across industrial, manufacturing, infrastructure, public sector, and mobility applications.

Our technologies are shaping production and people-related ecosystems to become increasingly connected and autonomous – ensuring a scalable, sustainable future.

Hexagon's Manufacturing Intelligence division provides solutions that use data from design and engineering, production and metrology to make manufacturing smarter. For more information, visit hexagonmi.com.

Learn more about Hexagon (Nasdaq Stockholm: HEXA B) at hexagon.com and follow us @HexagonAB.