



# Case study

## Crashworthiness analysis of EMU

### THE CHALLENGE

The Hyundai Rotem Company (Rotem) was developing a new lightweight, aluminium bodied electric multiple unit (EMU) – a passenger train consisting of more than one carriages which uses electricity as the sole motive power.

As part of the process, Rotem required independent verification of the EMU's compliance with the BS EN 15227 crashworthiness standard. This specification defines the design limits and driver survival space which must be met for potential crash scenarios: both head-on impact with an identical train, and impact with a large obstacle (*e.g at a level crossing*).

Frazer-Nash Consultancy were commissioned to perform non-linear finite element analysis of the new EMU design, in order to demonstrate that it met these requirements.

### OUR SOLUTION

A key requirement of the BS standard is that the modelling methods used to perform the initial assessment must be validated against component trials. In this instance, Rotem assessed their EMU by commissioning a range of full scale impact trials, examining both the performance of the energy absorbing components in isolation, and the full cab and intermediate vehicle ends.

To validate these tests, Frazer-Nash used finite element modelling in LS-DYNA to replicate the actual trial conditions achieved. We then simulated various collisions, and established very good agreement between the trials and our modelling.

In order to measure the crashworthiness of the EMU, we then developed a full CAD model of the front two carriages to assess the impact performance of a number of scenarios set by the standard. The results of the analysis were used to examine performance indicators including deformation of driver and passenger survival spaces and carriage decelerations in order to demonstrate that the vehicle did comply with the standards requirements.

### BENEFITS

As a result of the non-linear crashworthiness assessments performed by Frazer-Nash, it was possible to demonstrate that Hyundai Rotem's new EMU design met all of the requirements of BS EN 15227 that applied to the potential operating environment of the train.

The use of these models also enabled us to propose a number of design modifications to improve the performance of the cab design.

#### Client

Hyundai Rotem Company

#### Business need

Demonstrate crashworthiness performance of new train meets the requirements of BS EN 15227

#### Why Frazer-Nash?

Frazer-Nash has considerable expertise in design and structural analysis using FEA modelling

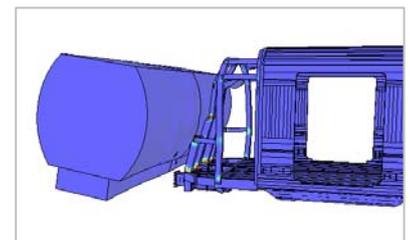


Figure 1: Impact with a large, deformable obstacle

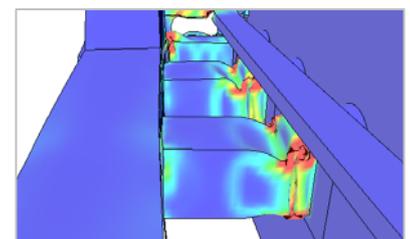


Figure 2: Performance of energy absorbing components

For more information please contact **Richard Jones** on **0117 9226242** or email [r.jones@fnc.co.uk](mailto:r.jones@fnc.co.uk)