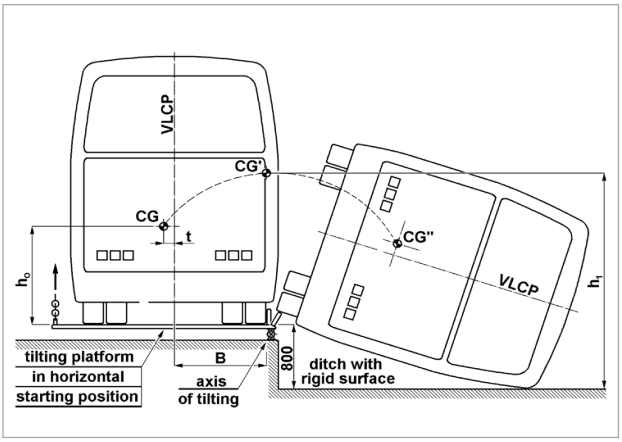
Simulation of Coach Rollover Performance using HyperWorks - Safer and Lighter by Virtual Design



ALEXANDER DENNIS

Key Highlights

Industry
Automotive

Challenge
Develop an automated process for running bus rollover tests

Altair Solution
Template developed in HyperWorks using HyperMesh as the pre-processor and RADIOSS as the solver which can be customised to each rollover process

Benefits
Repeatable and consistent results while achieving significant time savings

Safe and dependable transport is essential to UK society and the economy. One of the most popular forms of public transport is the bus due to being affordable, simple to use and offers routes that cover most roads. It is therefore essential to provide protection to bus and coach occupants during rollover type accidents.

In 1986, the UN ECE R66 standard was introduced. The R66 standard prescribes a clearly defined set of parameters and procedures for setting up a physical coach rollover test. Compliance can be demonstrated using a full vehicle rollover test, a rollover or pendulum test on a body section, or by calculation to the satisfaction of the approval authorities.

Physical coach rollover testing has proven to be repetitive and laborious with a complex set up process that can cause accuracy issues in the results.

Customer Profile

Alexander Dennis Ltd (ADL) is the UK's leading bus and coach manufacturer, employing around 2000 people at facilities in the UK, continental Asia and North America.

ADL produces a wide range of innovative and fuel efficient, low floor single and double deck buses, plus a full portfolio of coaches.

ADL had adopted a quasi-static approach to rollover testing using a calculation method based on coefficients derived from physical testing. More recently however, it became apparent that there was also a need to reduce weight and develop a more optimised structure and this required a more versatile approach.

ADL embarked on a project to realise a new way to demonstrate compliance with ECE R66 which would suit the industry, the

Keywords: Rollover, HyperMesh, Process Manager, R66, RADIOSS

Alexander Dennis Success Story

“Having a repeatable and consistent setup of our FEA models has allowed us to develop rollover structures and run what-if scenarios which was cost prohibitive before.”

Laurence Wood
Team Leader, Test & Development
Alexander Dennis Ltd

method of manufacture and the available skill set at ADL. They required a method that would automate the process of setting up and preconditioning a vehicle Finite Element (FE) model in order to simulate the vehicle rollover, while still achieving a lightweight and optimised structure.

ADL selected Altair’s HyperWorks tools in order to implement the required methodology and RADIOSS was used as the solver for this project. RADIOSS has been an industry staple for high-speed impact simulation for over 20 years. Automotive and aerospace companies value the contribution it makes in understanding and predicting design behaviour in complex environments. The tight integration with the HyperWorks environment makes RADIOSS a powerful design tool.

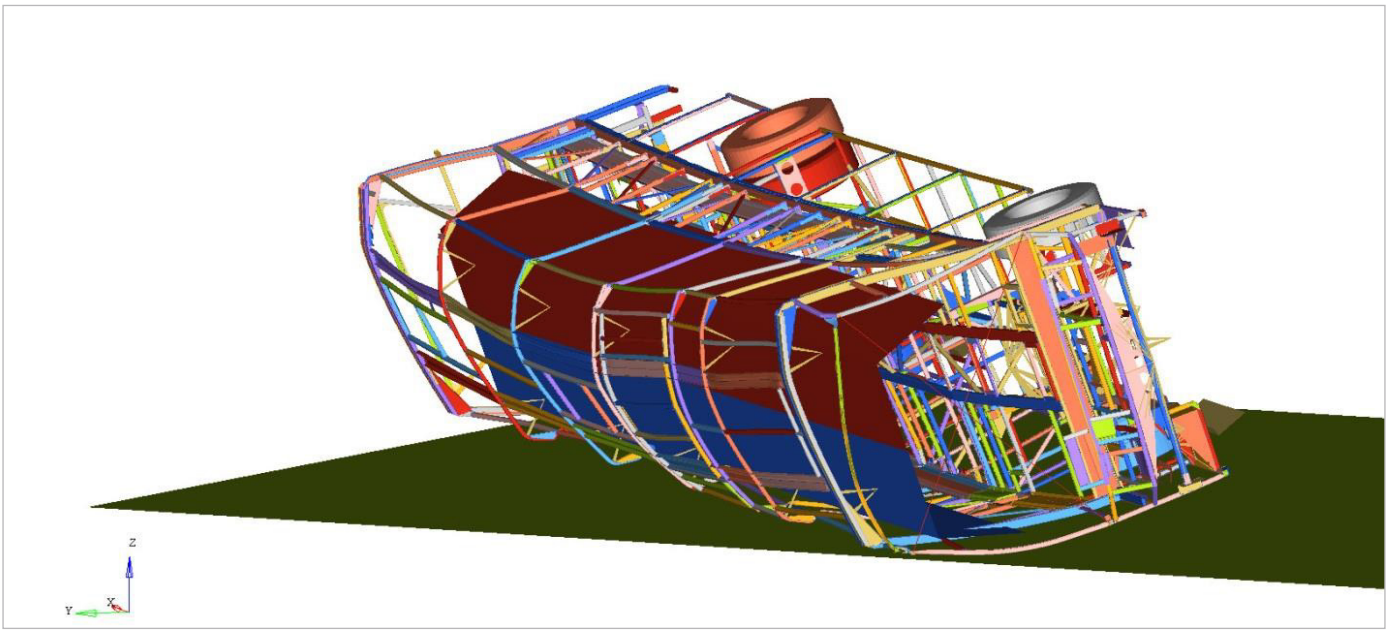
Process Manager Template Development

The starting point for the project was an existing simple rollover template which was provided by Altair. The template completed the basic tasks of loading the model and integrating the survival space, creating a platform to roll from, and the impact floor.

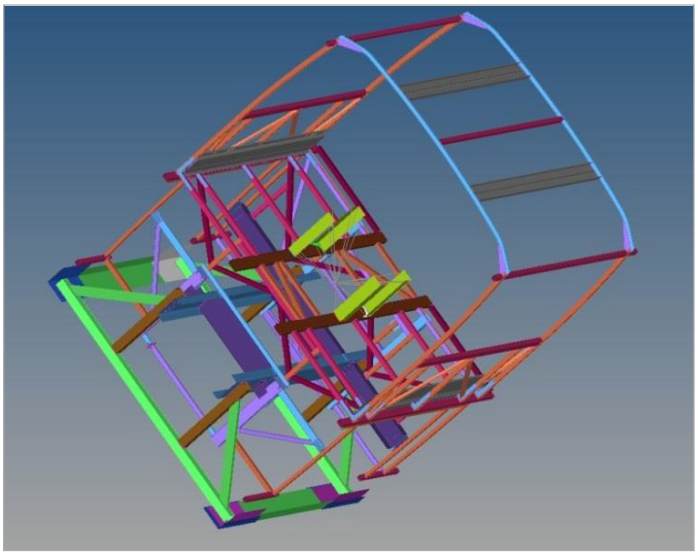
To assess the suitability of the existing rollover template and fully understand how it interacted with a vehicle analysis model, a full coach structure model was created in HyperMesh. The existing template was then modified by Altair to improve its suitability to comply with the R66 standard.

There were several key areas developed within the template to enable an accurate pre-process report, improve analysis time and speed up post-processing.

The first key area developed was the orientation of the axis in relation to the vehicle coordinate system. The use of multiple coordinate standards was considered and the template allows the



Full vehicle rollover simulation used to develop the rollover template



RADIOSS FEA model

Physical rollover test

user to select which is appropriate. The option to vary the stopper height on the tilting platform was incorporated into the template. This is due to the number of variables and model conditions that may be required to run an accurate rollover simulation.

The contact between the wheel/tyres of the vehicle and the stopper platform is automatically created to ensure correct departure of the model.

The direction of roll for the vehicle is defined with respect to the driver, including swapping the reference in the original template from left hand drive to right hand drive as standard for the UK.

Allowing a choice of different gravity units depending on the model units was also added.

There are three steady state conditions of a vehicle which were recognised in creating the template; a flat plain, an inclined plain with a stopper and an inclined plain with a stopper including overcoming friction and reaction loads. The option to select an unstable angle was introduced which also applies the required angular velocity associated with this unstable condition. The use of variable friction was also added to the template.

During this development, the rollover template was formalised to ensure the correct sequence of pre-processing of the FEA model to ensure due care and allow accurate physical representation by offering precondition variables to be set.

In order to satisfy Alexander Dennis' internal requirements and those of the approval authorities, the analysis centred on the comparison of a physical test with that of the same test generated in HyperWorks.

A physical single bay vehicle test coupon was constructed along with a rolling platform, so controlled and repeatable testing in accordance with the requirements of the R66 standard could be carried out. This physical testing was paralleled by simulating the same scenario using an independently contracted FEA model of the test coupon. This model was pre-processed both by the developed process manager template and by hand setup.

Achieving Accurate Results Every Time

Initial comparison of the FEA runs and the physical testing showed good correlation in both the physical motion and post impact deformation shapes.

The rollover template allows rapid and repeatable preconditioning of a suitable vehicle FEA model with little interaction from the operator.

The user is also able to set key variables during the pre-process creation and the unstable initial angular velocity applied to the FEA model uses a conservative worst case approach which trades reduced computational times against higher impact speeds.

HyperWorks has enabled accurate, repeatable and consistent results, even if the task is being performed by a different analyst each time. A significant reduction in analysis time has been successfully realised.

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About HyperWorks®

Performance Simulation Technology

HyperWorks is an enterprise simulation solution for rapid design exploration and decision-making. As one of the most comprehensive, open-architecture CAE solutions in the industry, HyperWorks includes best-in-class modeling, analysis, visualization and data management solutions for linear, nonlinear, structural optimization, fluid-structure interaction, and multi-body dynamics applications.

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