Success Story

# Improving Rudder Shock Loading Following a Nearby Blast Event Using RADIOSS

assystem

## Key Highlights

**Industry**
Marine

**Challenge**
Assess the capability of a ship's rudder assembly to withstand the shock loading following a nearby blast event.

**Altair Solution**
Dynamic explicit analysis was performed on a ship's rudder, using HyperWorks.

**Benefits**
The rudder carrier legs were strengthened to improve the bending resistance.

Engineers in the Marine, Shipbuilding, and Offshore industries face many design challenges including physical space constraints, extreme weather conditions, deep water and remote locations. These constraints create an extreme environment for the engineer to develop a sound, reliable and safe operating platform.

The use of simulation technologies to improve design efficiency and reduce physical testing costs continues to become one of the best ways to address engineering challenges in the marine industry.

## Customer Profile

50 years of experience have made Assystem a key partner of the world's largest industrial groups: Airbus, Areva, Alstom, EDF, EADS, General Electric, MTU, Peugeot, Renault, Rolls-Royce, Safran, Thales and more.

Designing and developing the products and services of tomorrow, building and ensuring the optimum use of their investments throughout the life cycle, coordinating and executing the realisation of their projects and infrastructure: Assystem's engineering teams make the difference and instil trust.

Keywords: HyperMesh, HyperView, RADIOSS, Finite Element Analysis

# Assystem Success Story

**"The Altair HyperWorks simulation suite allowed Assystem to determine the behaviour of a ships rudder subject to an adjacent explosion. Design issues were quickly identified, solved, and optimised."**

**David Hunt**
Principal Stress Engineer, Assystem

## Background

Prior to installation of a modified design of a ships steering gear, it was required to assess the capability of the rudder assembly to withstand the shock loading following a nearby blast event.

To solve this problem, Assystem have conducted dynamic explicit analysis using elastic-plastic material models.
The mesh was produced using Altair's high performance finite element pre-processor HyperMesh, the analysis was conducted in leading structural solver RADIOSS, and the results were reviewed using post-processing tool HyperView.
Multiple loading scenarios were solved to ensure that the limiting behaviour was captured. The model was verified using a combination of test cases compared to empirical solutions, by review of the in-built quality checks, and through monitoring output.

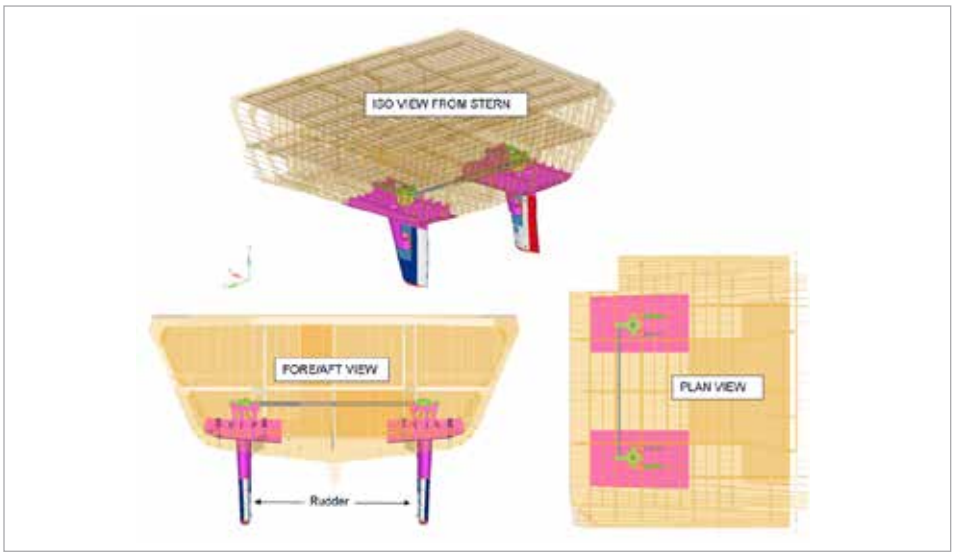
In addition to strength checks, sectional forces and seal displacements were assessed. Design improvements have been implemented, based on the results of the analysis.

## Methodology

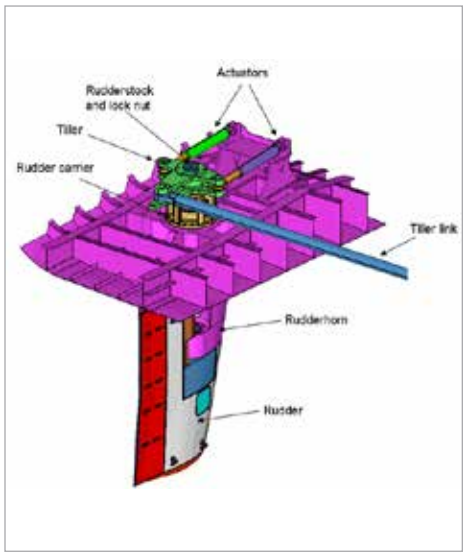
A finite element model of the steering gear, and adjacent ships structure was produced. Loads equivalent to the blast event were applied to the model, and the behaviour was reviewed and assessed.
A combined time dependent pressure and velocity pulse was applied to an assembly of the rudder, including a portion of the adjacent ship structure. The response of the structure was determined, monitoring plastic strain, seal deflections and section forces.Separate scenarios were considered, with loading co-incident to the three major axes.

The analysis was conducted using RADIOSS, a powerful design tool which is used across all industry worldwide to improve the crashworthiness, safety and manufacturability of structural designs.

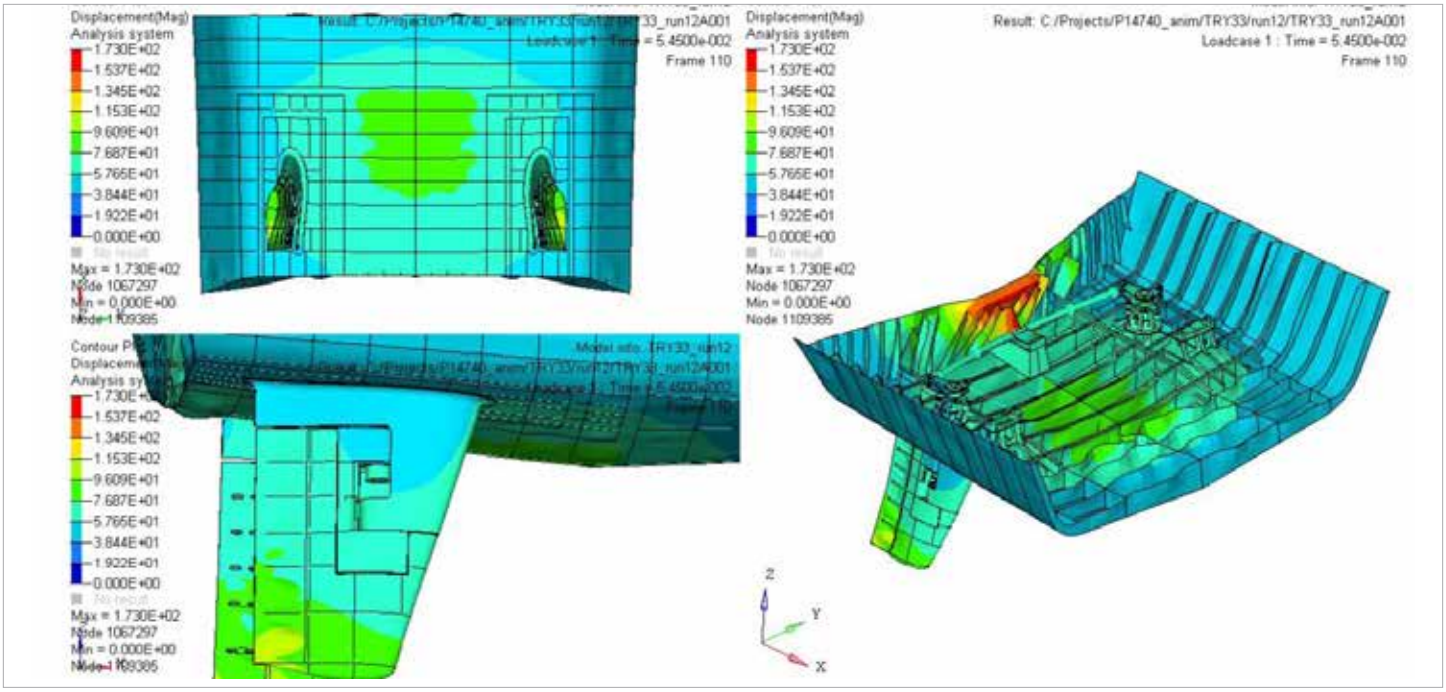
An elastic-plastic material model was used for the steering gear cartridges, so that permanent plastic deformations




*Vessel Stern with Steering Gear, Actuators and Link Bar*




*Rudder Assembly*




would be captured. Contact regions were defined, both for bonded regions, and frictional contact at adjacent surfaces.

An imposed velocity profile was applied to the extreme cut boundary of the hull. In addition, a pressure pulse was applied to the outer surfaces. The loads were considered to act in different directions, to ensure that the limiting behaviour was captured.

Verification of the analysis was performed as follows:

- Verification of the behavior of the element technology selected, by comparison to empirical formulae.
- Modal analysis was performed and compared against empirical formulae.
- Mesh refinement at regions of bending and local strain concentrations.
- Element quality checks were performed.
- Mass and reaction checks were performed.
- Element hourglass energies and mass scaling errors were reviewed.

The analysis was run using a computer cluster with up to 48 and 64 parallel cores. The double precision solver was used and the parallel processing option with RADIOSS was enabled to ensure that the number and location for the domains chosen for parallel solving would not affect the solution.

The following analysis output was calculated for assessment:

- Plastic Strain
- Section Forces
- Seal Movement
- Actuator Forces
- Velocity Response

## Design Improvements

Relevant verification checks of the analytical model were completed. Based on the results of the analysis, design improvements were implemented.

The initial design of the rudder carrier showed excessive plasticity in the lower legs produced by a bending moment resulting from impact between the rudderstock and carrier. The rudder carrier legs were therefore strengthened by connecting to the seal carrier to improve the bending resistance. The sectional properties were also increased at the shoulders.

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## About Altair

Altair's vision is to radically change the way organizations design products and make decisions. We take a collaborative approach to solving diverse and challenging problems through the strategic application of technology and engineering expertise. Developing and applying simulation technology to synthesize and optimize product development processes for improved business performance is our specialty.

From computer-aided engineering to high performance computing, from industrial design to cloud analytics, for the past 30 years Altair has been leading the charge to advance the frontiers of knowledge, delivering innovation to more than 5,000 corporate clients representing the automotive, aerospace, government and defense industries and a growing client presence in the electronics, architecture engineering and construction, and energy markets.

## 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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