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Bombardier uses VA One, vibro-acoustics simulation software, to simulate structure-borne noise transmission in trains

BOMBARDIER

THE CHALLENGE

- To simulate and rank the dominant noise and vibration transmission paths in a large double-decker train structure.
- To accurately predict the transmission of noise and vibration across a complex floating floor structure.

THE STORY

"Hybrid FE-SEA analysis is a real leap forward when it comes to acoustical modeling technologies and is likely to set the standard for industrial computational acoustics of large structures for the future. The innovative integration of FE and SEA methods within one model allows the user to solve problems that cannot be addressed by applying SEA or FE methods separately."

Ulf Orrenius,
Senior Specialist: Acoustics and Vibration, Bombardier Transportation

THE BENEFITS

- Simplification of vibro-acoustic model setup by reducing data management between multiple software.
- One unique solution for vibro-acoustic simulation across a wide frequency spectrum.

Bombardier Transportation is a global leader in the rail equipment manufacturing and servicing industry and serves a diversified customer base around the world. Its wide range of products includes passenger rail vehicles and total transit systems. It also manufactures locomotives, bogies, propulsion & controls and provides rail control solutions.

Reducing the noise and vibration inside the structure of a modern train to ensure high levels of interior passenger comfort is no easy task and requires detailed knowledge of the transmission paths. Bombardier Transportation decided to use ESI's VA One software for their vibro-acoustic analysis.

One of the challenges in controlling the interior noise levels in vehicles like trains is identifying the main noise and vibration transmission paths.

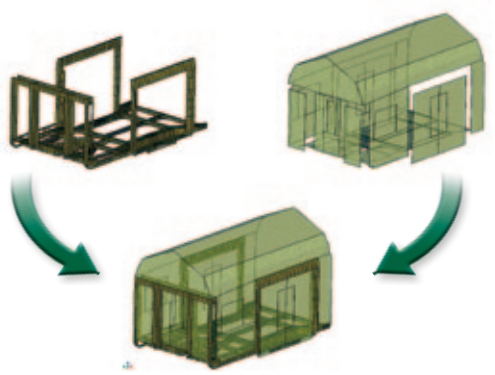
Traditionally Finite Elements (FE) and Statistical Energy Analysis (SEA) methods are used to simulate the noise and vibration transmission paths in train structures. However, one problem that often arises is that it is not possible to create system level models of the mid and high frequency response of large structures using Finite Elements. SEA is computationally efficient and well suited to creating system level models of the high frequency response. However, creating detailed models of complex junctions and subsystems can sometimes be more difficult. The frequency range for which neither FE nor SEA models are applicable is fairly wide and often critical for practical design issues. Using separate software for different frequency ranges may also result in loss of time and difficult model management.

VA One gives Bombardier accurate predictions across a wider frequency range

The floor of a train provides a good barrier to the transmission of air and structure-borne noise and vibration. Floating floors are often used to reduce interior noise and vibration in rail vehicles. Bombardier therefore focused its initial modeling efforts on the vibration reduction across the floating floor of a double Decker train.

To overcome the modeling challenges, Bombardier chose the "Hybrid FE-SEA" module of VA One in their analysis. This module implements a unique method for rigorously coupling FE and SEA in the same analysis. The method offers enhanced prediction capabilities in terms of widened frequency range coverage and reduced calculation times.

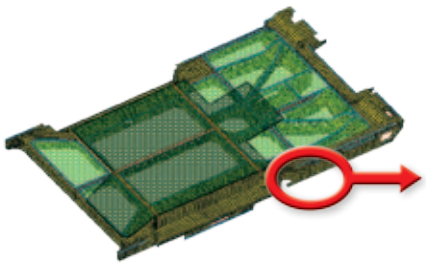
FE and SEA components assembled into a Hybrid FE-SEA model of a double decker end section.

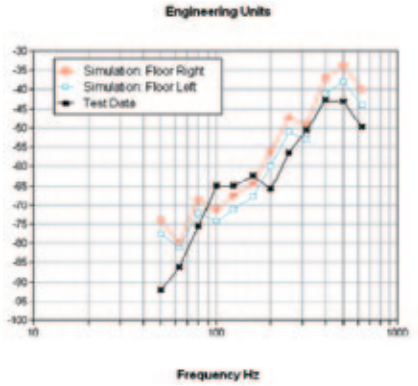


The study demonstrated that VA One could accurately predict the transmission of vibration across a floating floor design. It also enabled Bombardier to identify the key physical parameters controlling the transmission across the floor and evaluate different isolation designs.

The next step in the study was to use VA One to create a more detailed system level model of a train structure. The analysis of the floor provided insights into the physical transmission paths and enabled the design of additional noise control treatments to be evaluated by simulation.

Vibration level of inner floor: prediction vs. experiment





Finally, a series of design studies were performed to evaluate the radiation efficiencies of heavily damped floor panels using the Hybrid FE-SEA module of VA One. The results from the analysis compared well with measured test data.

The success of Bombardier Transportation and ESI's project can be summed up as follows:

The Hybrid FE-SEA modeling in VA One improves prediction results as it:

- Allows more detailed descriptions of complex junctions and components to be included in standard SEA models.
- Extends the frequency range covered by simulation.
- Enables system level models of large structures to be used for design.
- Permits calculation of radiated acoustic power for arbitrarily excited/damped complex structures.

Through the project, Bombardier Transportation validated the results obtained from VA One against test and highlighted the benefits of using a Hybrid FE-SEA modeling approach. The use of VA One early in the design stage helps Bombardier Transportation find optimum design solutions without adding extra cost and weight. Bombardier also uses this method to evaluate noise control measures from aircraft panels produced by the Bombardier Aerospace division.

ABOUT ESI GROUP

ESI is a world-leading supplier and pioneer of digital simulation software for prototyping and manufacturing processes that take into account the physics of materials. ESI has developed an extensive suite of coherent, industry-oriented applications to realistically simulate a product's behavior during testing, to fine-tune manufacturing processes in accordance with desired product performance, and to evaluate the environment's impact on product performance. ESI's products represent a unique collaborative and open environment for Simulation-Based Design, enabling virtual prototypes to be improved in a continuous and collaborative manner while eliminating the need for physical prototypes during product development. The company employs over 750 high-level specialists worldwide covering more than 30 countries. ESI Group is listed in compartment C of NYSE Euronext Paris. For further information, visit www.esi-group.com.

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