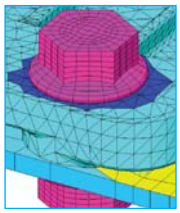
Customer Success Brief

fe-safe™

Extending a complex predictive process for structural durability



VOLVO

Challenges:

- Reduce fuel consumption and extend product life while integrating customer-driven functionality improvements
- Develop an accurate process to predict product life and assess design changes quickly
- Significantly reduce physical testing to only a few accelerated tests to confirm life prediction

key fe-safe™ Capabilities:

- Integration with Volvo's ANSYS Finite Element (FE) software and proprietary loading libraries
- A range of fatigue methods, including Smith-Watson-Topper (SWT) with Neuber correction
- The ability to correctly assess the contribution of assembly versus duty-loads and related stresses to overall fatigue life

Conclusions:

- Excellent correlation between predicted product life in fe-safe™ and real-world tests
- Smooth and productive integration of fe-safe™ into Volvo's hybrid approach to complete vehicle modelling
- Using fe-safe™ opens up opportunities to further increase reliability and reduce costs

Innovation in power

Volvo trucks are sold and serviced in more than 130 countries over the world, through over 1,000 dealerships and 1,800 workshops.

More than 95% of the trucks Volvo builds are in the heavy weight class (over 16 tons) which makes Volvo Truck Corporation the second largest heavy-duty truck brand in the world.

Integrated development and production take place in Sweden, Belgium, Brazil and the USA, with truck assembly operations in a number of additional locations, both at Volvo plants and in collaboration with locally-owned industrial concerns.

With continuing competitive pressure and challenging multiple government standards on issues including fuel mileage and pollution, the technology required to put Volvo's market leading trucks on the road rivals, and in many cases surpasses, that found in the aerospace industry.

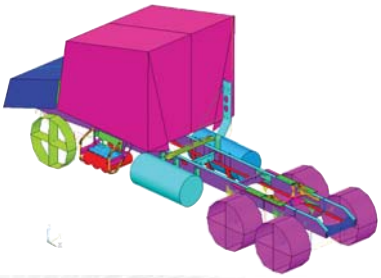
Evolving design approaches

The basic design of a heavy truck chassis has remained relatively unchanged for the past 100 years: two parallel frame rails connected intermittently by cross members. The chassis provides the foundation for mounting all other components, such as the cab, engine, and suspensions. However, continuing customer-driven enhancements and government regulations demand ongoing improvements to the overall design approach.

The crucial challenge for the heavy truck industry is to reduce the weight of the mature vehicle components without sacrificing any performance characteristics. Optimising design geometry, using alternative lightweight materials, or creating completely new designs are all possibilities; but as is often the case in structural design, stiffness changes in one area of a structure can result in increased loads in other areas of the structure and can also affect handling and safety.

Complete vehicle modelling

To meet these complex structural design challenges, the Volvo Technical Center (VTC) in Göteborg, Sweden, developed a Complete Vehicle Modelling (CVM) system. This system level approach uses an entire virtual structural model of the truck which can then be subjected to any of Volvo's standard endurance test tracks. Using the CVM system, time histories of engineering loads for a given design can be extracted for any location on the truck. The figure below shows a typical CVM model for chassis structural design.



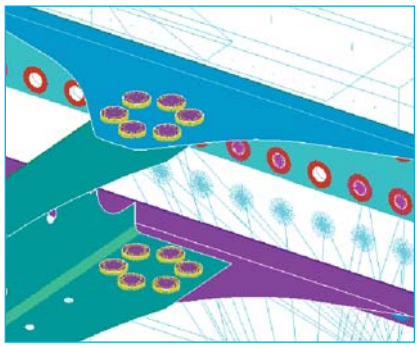
"Recent advances in fe-safe™ enable accurate prediction of fatigue life when analysing models with contact between components constructed of solid elements."

Rick Aveline, Project Design Engineer, Chassis & Vehicle Dynamics

Extending CVM for durability:

using fe-safe™ to predict fatigue life

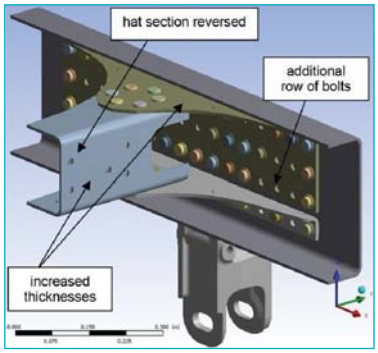
While the CVM system provides an efficient means for determining transient loads, additional details, such as transient stresses and strains, are required for effective fatigue life prediction. Volvo has developed a hybrid approach, one that extracts transient loads from the CVM system and then integrates these loads with detailed FE models to calculate the stresses and strains needed by fe-safe™ to accurately predict fatigue life. The figure below shows a model using this combined approach: the light blue lines represent the system-level CVM model, whilst the detailed finite element model is shown as shaded geometry (bolted channel sections).



Improving design by analysis

Shortly after fe-safe™ was integrated into the design process at Volvo, a prototype design failed during its accelerated endurance test (AET). The new system was able to quickly compare the predictive results of fe-safe™ to the real-life failure, predicting cycles to failure within a 4% margin. The fe-safe™ integrated approach was then used to quickly assess the impact of a number of possible design changes. These included changing the thickness of several structural channel sections, varying the location and the number of bolted connections and even swapping the orientation of the key hat section. A considerably improved design was realised in only a few days which was both stiffer and had a predicted fatigue life that was 12 times greater than the failed design.

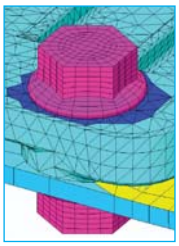
The improved design is shown below:



Further refinements:

fastener modelling

The FE method includes sophisticated line (beam) and surface (shell) elements to synthesize the behaviour of solid structures. In the previous real-world example, the interaction between the fasteners (rivets) and the structure was approximated using compression-only line elements quite successfully. However, this simplification requires additional user modelling time and may not always provide an accurate representation, especially when assembly stresses are to be considered. With the advent of accurate solid elements and robust contact modelling, the opportunity to further streamline the modelling process and to take into account assembly stresses is now available. fe-safe™ supports these latest approaches and also provides for the accurate consideration of how assembly versus duty-related stresses contribute to overall fatigue life.



safe technology limited

Safe Technology Limited is the technical leader in the design and development of durability software and is dedicated to meeting its customers' most demanding applications.

As a private company, Safe Technology is able to take a long-term view of software development and the research and industry collaboration needed to address real world, industrial applications. Its independence and focus enables quick response to customer feedback so that its software genuinely reflects the industrial and commercial requirements of engineers and designers.

In-depth knowledge of fatigue combined with expertise in software development allows Safe Technology to provide outstanding service - with standard and advanced training, software support, and consulting services provided by fatigue experts.

Safe Technology develops, markets and supports its software products directly from offices in the UK and USA, by a network of independent distributors worldwide and via the worldwide SIMULIA network.

To learn more, please visit our website where you can learn about our software products and related services, and register to download technical papers by our users on real world applications. You can also find the contact details for your local office or representative.

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