SIEMENS

Sumitomo Heavy Industries Marine & Engineering

Responding quickly to ship structural analysis needs with easy-to-use Femap

Products

Femap, NX Nastran

Business challenges

Multiple-skill development to support design and analysis

Flexible support for changing classification society rules and customer demands

Development upstream from the design stage

Keys to success

Analysis with Femap

Visualization supporting high-precision, high-quality analysis

Flexible modeling functions

Results

Increased the number of designers who understand both plans and analysis

Accelerated development and reduced costs

Improved the precision and quality of analysis calculations

Sharpened the design intuition of new employees during training

Accelerating design and reducing costs

Femap implemented as an analysis tool for designers

Sumitomo Heavy Industries Marine & Engineering Co., Ltd. builds ships with a focus on mid-sized tankers. Since the company's founding in 1897, it has built more than 1,300 ships, including the Nippon Maru and Kaiou Maru large-scale training ships.
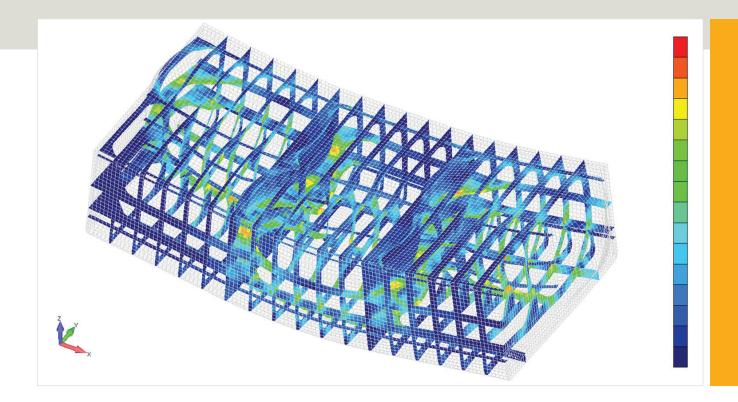

The Structure Design Group in the Design Department of the Construction Management Division manages a wide range of operations, such as creation and submission of the ship's key plans together with the approval documents to the ship owner and the classification societies, incorporation of feedback comments, creation of the production plans, ship performance calculations, preparation of numerical control (NC) operation data, and measurement of vibrations during the sea trials. The department uses Femap™ software from product lifecycle management (PLM) specialist Siemens PLM Software as a pre- and postprocessing tool for performing various strength and vibration calculations relating to the ship's structure.

The group introduced Femap nine years ago to replace its previous UNIX™ system analysis software. Currently, the company has four Femap licenses for pre- and post-processing and one NX Nastran license as a solver.

Now the staff concurrently performs both design and analysis due to multiple-skill development. In addition, the group is also expanding the use of Femap by its full-time designers.

"The software that we previously used was difficult to operate and could only be used by highly skilled staff," says Yuji Hirose, an engineer in the structure design group.

"The support cost was high and the maintenance was difficult. We were looking for a tool that the designers could also use, and we implemented Femap." Hirose identified the superior performance/cost ratio and the fact that it is a tool that the designers can use as the primary reasons for implementing Femap. The group uses NX Nastran as the solver based on its "reliability, stability, and name recognition," says Hirose.

Testing and experimentation with physical prototypes are not possible when designing a ship. Femap is used as a substitute for experimentation to perform analysis simulations of various hull structures. In addition, ship structures must be fixed before transitioning to the detailed design stage, because any changes during that stage can have a significant impact. For this reason, the simulation results are used to confirm the structural design. In addition to deciding the shape of the transverse members based on the analysis results, analysis simulations using Femap are also widely applied to the planning of the structural reinforcement for installing the outfitting equipment below the deck.

Strength calculations comply with classification society rules, using internal expertise

Certification and a seal of approval must be obtained from a classification society in order to actually operate a ship. There are several such classifications around the world, and the choice of certification location is decided by the ship's owner. However, most classifications use a common standard for strength calculations and evaluation of the hull construction for bulk carriers and oil tankers. The analysis results for the common regulations are compiled in a report and submitted to the classification society.

"The methods for meshing and creating the model are stipulated in the classification's rules," Hirose explains. "Previously, spreadsheet calculations were sufficient, but recently model-based calculations are becoming relatively more important. For this reason, work that requires finite element modeling tools is increasing. The creation of documentation for submission to the classification society is also an important part of our work. With Femap, we can do the work on a personal computer, so it's

easy to copy the models and analysis results and re-use them in the report. It's a big help."

Detailed consideration is also required to determine the size and arrangement of the ship's structural member. The finite element method (FEM) is applied in many situations such as analysis of the ship hull's vibration-proof design and the local strength calculations based on internal company standards. "Because testing is not possible, some aspects are based on experiential engineering," says Hiroshi Negayama, manager of the Structure Design Group at Sumitomo Heavy Industries Marine & Engineering. "Based on feedback about past experiences, we repeatedly revise our own internal standards." This accumulated knowledge is applied in analysis using Femap.

Members of the structural design group are now participating more frequently in the planning and development stages, which precede the design stage, to determine the specifications of the ship under development. Typically, the development starts based on the proven ship design from the previous generation, and then feasibility studies are conducted to see whether design changes to make the ship lighter and leaner are practical. "The design and analysis engineers are also involved in the discussion of the

specifications and structure of the next ship being developed," says Negayama. "Analysis calculations are performed at an early stage while discussing ideas for the new ship to check that there are no strength or vibration problems. For this reason, we need engineers who have cross-training in both analysis and plans."

Analysis calculations using Femap and NX Nastran are used not only for the design of the ship itself, but also for strength calculations during construction. Generally, large-scale ships are constructed by separating the hull into several blocks that are then combined using block assembly methods to create the final shape. During the assembly process, the large blocks, weighing as much as 500 tons, are hung up by a crane for installation in the proper position. Appropriate reinforcement is examined based on the strength calculations to ensure that no problems occur while moving the block.

Accelerating analysis and reducing costs with Femap
Each designer at the company performs calculations by sending data from Femap on a PC to NX Nastran on a server. "Sending a job from the PC to the server allows you to make effective use of the PC while the calculation is running," Hirose explains. "You can do this without actually thinking about where the calculation is

"Development discussions progress quickly when the participating members have knowledge of both analysis and plans."

Hiroshi Negayama
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taking place, so you don't experience any inconvenience. Femap and NX Nastran are both developed by Siemens, so the compatibility is good and you can work quickly."

The static analysis model used by the company contains 50,000 nodes and 120,000 elements, while the fixed vibration analysis model, based on a model of the entire ship, typically includes 10,000 nodes and 25,000 elements. Femap is also used for this modeling, with great efficiency. "When modeling frequently used beam elements, defining the cross-sectional shape automatically calculates the rigidity and offset amount, which is useful," Hirose says.

Sometimes the mesh for part of the model must be rendered in detail in response to requests from the classification societies. For example, the entire model may use a coarse mesh, while the welded connection parts around it are analyzed with a fine mesh. In such situations, the company substitutes another separately created model with a fine mesh for the target area. Femap simplifies this process. "Previously, the section that needed a fine mesh was cut out and analyzed separately, which took a lot of time," Negayama says. "Now, we can combine coarse and fine areas in the same model for analysis. To simulate it with the continuity in terms of deformation, inserting the fine mesh into the entire model and performing the calculations yields higher precision and improved results."

Before implementing Femap, Sumitomo Heavy Industries Marine & Engineering performed many tasks with manual calculations using spreadsheets and other tools to examine numerical values. Now the calculation results can be visually confirmed using Femap. The company values the intuitive user interface and advanced graphics of Femap. "You can visually confirm whether a model's construction is good or if the correct requirements have been applied, which reduces the number of mistakes," Hirose says. "Also, the visual calculation results are easy to understand

and evaluate. As a result, the quality has also improved. When we used Excel, it required a lot of time and manpower. Now, a single person can support many patterns, and we have realized acceleration in the time and a reduction of man-hours."

Toru Ozawa, an engineer in the structural design group, also describes the cost reduction benefits: "Femap costs less compared to other software solutions, so the annual maintenance costs also contribute to cost reduction," he says.
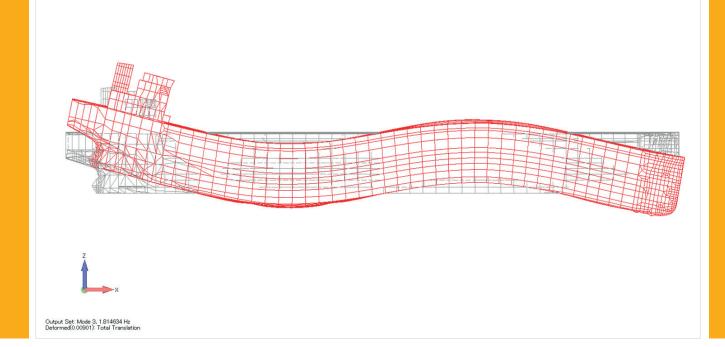
Analysis work increases to fulfill customer needs and classification rules
The shipping environment is changing with the times. Currently, there are increasing demands to deal with safety and fuel efficiency improvements, gas emission regulations and environmental issues, as well as clarity in design. New types of designs are needed to cope with these demands, and analysis work using Femap is increasing.

The classification's rules have changed, and the new regulations are being applied to the contracted vessels as of July 2015. "Under the new regulations, the target of the ship analysis has been changed from just the hull's mid-part holds to all of the holds, including the forward and aft holds," Hirose explains. "This will quadruple the amount of work."

Improvements in the propeller and helm attachments are needed to improve fuel efficiency, requiring confirmation of the strength and vibration control functions. On the environmental front, it is now a requirement to process ballast seawater within the hull and dispose of it locally in a form that is not harmful. Vibration control and strength calculations for the lower structures are required to install such processing equipment on the deck.

Measures to deal with gas emission regulations are also an important environmental aspect. "Ocean-going ships generally use

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low-priced heavy fuel to reduce operating costs, but it is difficult to satisfy gas emission regulations with such fuel," Negayama says. "In particular, it is necessary to switch to a fuel that produces clean gas emissions when entering European ports. Therefore, ships now require new features such as added tanks to support multiple types of fuel and the installation of processing equipment to deal with gas emission regulations." While these features are required for new ship construction, gas emission regulations also apply to ships currently in service. Inquiries regarding modifications to separate tanks into two are also increasing.

Femap is also being used to investigate the cause of defects occurring in currently operating ships and provide solutions. "A ship is useless if it is not operational, so we have to shorten the repair period as much as possible," Ozawa says. "At times like that, Femap is a big advantage, because it's easy for anyone to use."

Easy for anyone to use, effective for new employee training

Previously, only a few people were able to use the primary UNIX analysis tool, so analysis was performed by a dedicated staff. Now designers are able to use Femap on their personal computers. The Femap user interface is in Japanese, so even beginners can use it without hesitation. Femap is also used in new employee training to improve education in the strength of materials and other areas. In this training, employees acquire basic knowledge through the Femap tutorial and then gradually transition to analysis based on actual design plans.

Negayama describes the merits of promoting the use of Femap at the company to cultivate cross-trained designers who are skilled at both plans and analysis. "It is very difficult for a new employee to just look at a plan and have a concrete image of where the stresses will be placed and how to shape each piece," Negayama says. "I think that viewing through a simulation makes it easy to understand the difficult structural areas and sharpen your design intuition."

With the increase in workers who understand both design and analysis, the use of Femap is expanding to other areas. In

addition to analyzing work vessels, and marine structures, the company also receives requests for strength analysis of construction equipment and shovel arms from other companies within the Sumitomo Heavy Industries group.

The company plans to use Femap to respond to future increases in analysis work due to changes in shipping regulations and the diversification of customer needs. "We hope to be able to handle more analysis work by using Femap, which is easy even for designers to operate," Hirose says. "We also want to implement

customizations using the Femap application programming interface to further improve the processing performance."

Currently, the creation of documents for submission to the shipping bureau requires a lot of time and effort, so the company aims to further increase the speed of operations. "In the future, we plan to reduce lead times by implementing customizations to automate postprocessing and calculation sheet creation based on a link with the shipping bureau's creation software," Hirose explains.

"The Femap implementation and maintenance costs are low, which resulted in an overall cost reduction."

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