By ANDREW SAFER

Fatigue analysis zooms in on hull details of ice-strengthened ships

Due to the strong interest in the exploration and development of natural resources in the Arctic, Lloyd's Register has introduced the ShipRight FDA (Fatigue Design Assessment) ICE procedure to assist shipowners and operators in assessing the fatigue performance in the hull structures of ice-strengthened vessels.

Canadian Sailings spoke to Claude Daley, Professor of Engineering in the Ocean and Naval Architectural Engineering Group at Memorial University of Newfoundland in St. John's, to put the fatigue performance of ice-strengthened vessels into context.

Between 1992 and 2008, Daley helped develop the structural standard for the polar class rules, an international safety framework for ships operating in polar waters. As principal investigator of the Sustainable Technology for Polar Ships and Structures project, his current focus is on understanding the impact forces of ice and steel at actual vessel speeds in the Arctic, and developing a tool to assist engineers and designers in designing ships and offshore structures for year-round Arctic operations.

ShipRight FDA ICE examines the quality of design details and assesses the fatigue damage to standard joint configurations caused by ice loads for ice-strengthened ships. This supplements the ShipRight FDA level 2 procedure, which assesses the fatigue damage due to wave-induced loads. For such wave-induced fatigue, the assessment includes ship voyage patterns, ship motions and hydrodynamic loads. A calculation is made based on the voyage's expected wave height, provided by a historical database, and the total distance (for example, 1,400 one-metre waves over 1,000 miles).

Detailed structural design – such as how one section of steel is joined to another, how to specify a weld, and how the corners are shaped – is often left to the ship builder, Daley notes. "But since the local details have a huge effect on fatigue performance," he explains, "Lloyd's has added a special set of assessment tools to help the builder focus on the structural details in ice-class ships. Doing this extra analysis for fatigue performance gives the owner comfort and shows the insurance agent that the risk has been addressed."

Daley points out that in open water, there are significant vessel motions that produce global loads, which is not the case for vessels operating in ice. "Because the ice loads are high and localized," he says, "they have to put in a lot of steel in the hulls of these ships to directly resist these loads." He adds that as a result, the shell plating has more fatigue resistance than in a non-ice-class vessel. He says the new assessment procedure is "a prudent thing to do for large capital ships with ice-class, especially novel ones for which there is little experience," particularly in light of the significantly higher cost of repairing non-ice-class ships.

To receive the FDA ICE notation, all of the framing end connections at the side shell ice belt of the cargo hold region must be addressed. Areas outside this region are specially considered.

It's novel to have an ice-load model built into an assessment tool, Daley says. He adds that ship-ice interaction is much more complex than ship-wave interaction, and that research is still being done to understand the loads that result from navigating through ice. The data that's available comes from a small set of vessels instrumented with strain gauges "which is enough to validate certain types of loads," he says, "but it doesn't predict all of the things that can happen in ships in ice. We need more study."

Photo: Memorial University of Newfoundland

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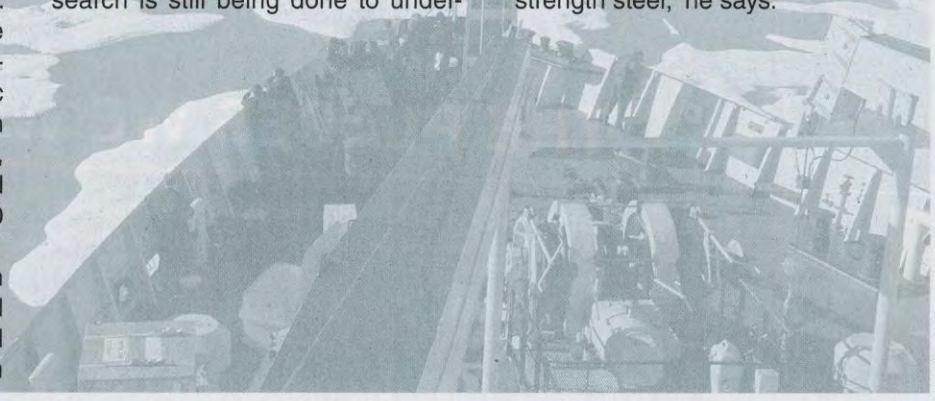
Daley points out that while there's a cost advantage to using higher-strength steel, because the steel is thinner, it is more prone to fatigue. "The local design becomes much more important to check with higher-strength steel," he says.



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