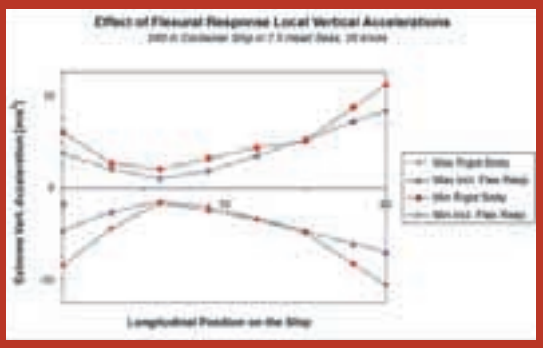
MARIN addresses aft-body slamming concerns

High propulsive efficiency has motivated many designers to apply a relatively-flat aft-body but in some cases this shape has raised concerns about the possibility of aft-body slamming.



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There is no doubt that relatively-flat stern sections have definite advantages in calm water, compared to V-shaped sections. Fuel savings of up to 10% are not uncommon.

But when a ship sails among waves, there is a possibility of stern emergence. Both the pitch motions and the incident wave contribute to this phenomenon which occurs mostly in following and head seas. However, because a flat stern tends to "cling" to the water surface at higher speeds, stern emergence is most likely in the lower speed range.

In the course of re-entry, the stern experiences an impulsive load which can be characterised by an impulse and a duration. If the sections are flat and the entry-velocity is high, the duration of the impulse is sufficiently short to excite the lower eigen modes of the ship structure.

Discomfort and passenger concern related to the noise and transient bending and torsional deflections have been reported from onboard observations. Quantifying "stern slamming" is challenging and relevant data is often hard to obtain.

Different techniques

MARIN applies two methods to quantify the flexural response. The first technique uses a large number of pressure gauges and a fast-sampling technique to quantify the pressures during an impact and impulsive loads are derived. These are then used in a Finite Element Model of the ship to quantify the transient flexural response.

A second technique mimics the structural stiffness of the prototype in the model. The lowest mode shapes in bending can be realised relatively-easily with a segmented model. An important advantage of this technique is its simplicity, the fact that it accounts for (possible) hydro-elastic interaction between the pressures and the flexural response and the direct test results. A disadvantage is that the modelling of the higher and more complex mode shapes, is difficult.

A study that compares both techniques was published in cooperation with Ingalls Shipbuilding Corporation[1]. Generally, the results showed that the vertical accelerations at the vessel's extremities increase considerably in those cases where stern slamming occurs. The figure gives an example of a medium-size, fast, container vessel in head seas In test conditions, the flexural response increases the vertical accelerations fore and aft, by some 20-40%. Aft-body slamming affects, through the related hull girder vibrations, the operational performance of ships in certain wave conditions. The above techniques enable ship owners and yards to find an optimum compromise between these problems and a high fuel economy in good weather.

[1]) Kapsenberg G.K, Veer A.P. van 't, Hackett J.P. and Levadou M.M.D., 2002, Whipping loads due to aft body slamming, Proceedings, 24th Symposium on Naval Hydrodynamics, 8-13 July, Fukuoka, Japan. Kapsenberg G.K., Veer A.P. van 't, Hackett J.P. and Levadou M.M.D., 2003, Aft-body slamming and whipping loads, SNAME 2003 Annual Meeting, October 2003, San Francisco, USA.