A SWATH solution for River Westerschelde ferries

Seakeeping tests.

Jaap Allema,
Reint Dallinga &
Frans Quadvlieg
J.Allema@marin.nl

Damen Shipyards Gorinchem is awarded a contract to build two passenger & bicycle ferries. As the Province of Zeeland and the yard opt for a SWATH solution, MARIN does the tests.

On the Dutch river Westerschelde, between the ports of Vlissingen and Breskens, on the approach to the harbour of Antwerp, a new passenger ferry service is set to start for pedestrians and bicycles. Car ferries on the route are due to be taken out of service because a tunnel running under the Westerschelde has been built for vehicles. Damen Shipyards Gorinchem was awarded the contract by the Province of Zeeland to build the two passenger & bicycle ferries. Both decided to opt for SWATH (Small Waterplane Area Twin Hull) ferries because they had to be able to handle relatively tough requirements for sustained speed (operational reliability) and motions (comfort) and they could even face weather conditions up to a Beaufort 9. SWATH designs also usually offer a significant deck space, which gives much more freedom in the design and division of the superstructure.

Damen Shipyards Gorinchem, in close co-operation with Southampton-based Nigel Gee & Associates, supplied MARIN with the basic hull design which was to form the starting point for a series of calculations and model tests to analyse and optimise the hydrodynamic qualities of the ferry. A fruitful co-operation between consultancy firms Sovereign Marine Services (consultant to the Province of Zeeland), Damen Shipyards Gorinchem, Nigel Gee & Associates and MARIN, generated a hull design which performs very well.

Sailing on schedule

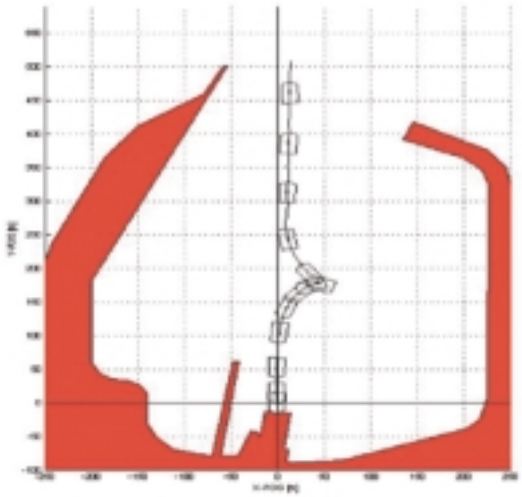
In co-operation with Nigel Gee, a CFD study was started to investigate and optimise the initial lines' design from a calm water resistance/propulsion point of view. By deploying MARIN's potential flow code, RAPID, several changes in the hull form were investigated and a modified hull form was used for the model tests. For these tests, a 1:10 scale model was made of the two floaters, struts and the wet deck. Calm water propulsion tests were

carried out on several static and dynamic trim conditions with steerable fins to create a pre-defined dynamic trim. The tests yielded important information about the trim needed to realise a minimum of the required propulsion power. Tests also showed that for the lower speed range (below the design speed of 16.5 knots) the fins appeared to create a considerable drag. Hence, it was decided to use a dynamic ballasting system instead of the control fins to control the dynamic trim of the SWATH during its journeys.

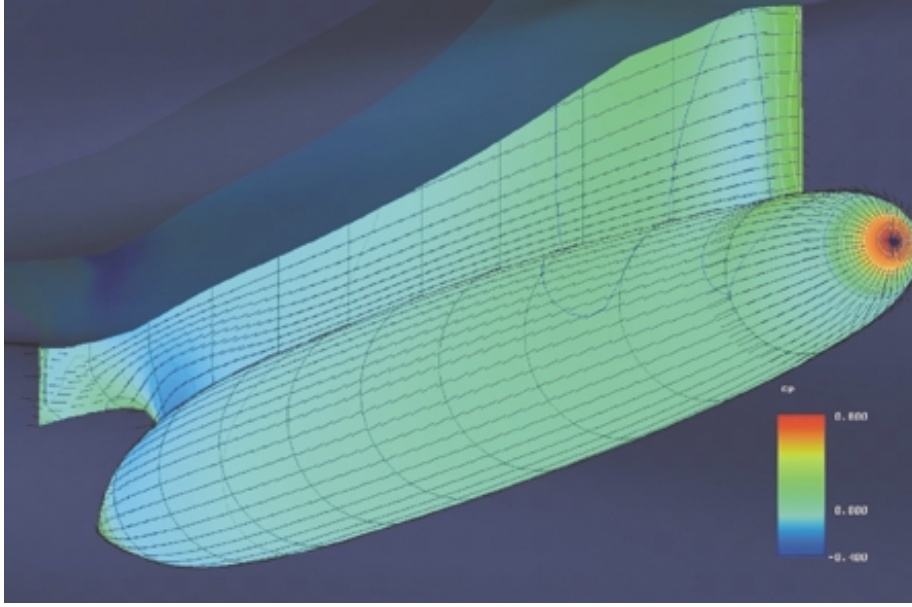
Steering to success

As the Westerschelde is a river with a high traffic density and because the harbours are subject to heavy traffic, the manoeuvrability of the ferry was an important consideration. This issue was addressed in an early stage. At the location of the two harbours, the River Westerschelde shows one of the largest tidal differences in the whole of the Netherlands. Differences between low tide and high tide are approximately four metres, so for a certain amount of time the vessel is sailing in relatively shallow water. Harbour manoeuvres (which are in general slower in shallow water) are therefore critical if the tight sailing schedule is to be maintained.

Using model tests in both deep and shallow water, the impact on the sailing schedule was analysed. Best procedures to leave the harbour and several operational aspects have been studied and important engineering insight was obtained concerning the best modes of steering and operational aspects. Steering by means of the differential use of the propeller thrust proved to be a very powerful way of controlling the vessel.



Visualisation of bird-eye view of Breskens harbour manoeuvring test.



Rapid flow code.

Comfortable transit

The last stage dealt with comfort, operation and structural loads. After an early check on the behaviour and wave loads, based on calculations, model tests were used to obtain information on the aspects that are not accessible by means of calculations. Calculations were performed with the PRECAL-SWATH panel code developed by the MARIN Co-operative Research Ships group. Variations covered the hull form, the position and size of the four control fins and the optimum control. The results in terms of the airgap, comfort and fin angles provided sufficient confidence to enter the verification stage.

Important aspects of the SWATH design which are less accessible by means of calculations, are the loss of longitudinal stability at forward speed, the viscous damping in heave and pitch and the low-frequency sway-yaw reaction forces in sway and yaw (relevant in waves from the stern-quarter). These aspects were addressed by means of model tests with a free-running model with active rudders and control fins. These tests also served as a final check on the global structural loads (in particular the splitting forces) and passenger comfort.

A presentation entitled “Rough seas and small fast passenger ferries: the Damen SWATH solution” was given at the RINA conference on High Speed Craft on November 11 and 12, 2002, by R. Vrugt, P.H. Noordenbos and E. Dudson and on March 13, 2003, for the Naval Architects of the Royal Institute of Engineers in Delft, the Netherlands. MARIN