

The effects of passing ships on moored vessels

FORCE DETERMINATION The effects of passing ships on moored vessels can be analysed in various ways. MARIN (Maritime Research Institute Netherlands) is involved in several projects that calculate these forces.



Harbours being built-up (top-down): construction of main waterways, secondary shipping channel, two barge docks, final test set-up

MARIN's shallow water basin facilitates a wide range of model testing. A recent ship passing study showed this versatility when two complete harbours were modelled, including more than 4,000m of their surrounding shoreline. This study aimed to investigate the feasibility of two possible new barge dock locations at an existing terminal in Beaumont, Texas, USA. The main objective was to assess the mooring line loads on two barges moored in the dock when a vessel passes. Model testing of passing ship effects in narrow waterways requires special attention. Modelling the approach of the passing vessel is one of the points that need additional care. When the passing vessel is not accelerated appropriately in the basin, unwanted shock-type waves propagate in front of it. For the Beaumont terminal study the model setup ensured that no shock-type waves were generated.

An additional point of interest is the modelling of the mooring system. Monopiles, fenders and mooring lines can all be modelled in the basin. However, for this project a numerical model was set up for the mooring system of the barges. The barges were rigidly moored in the basin and the measured (time-dependent), total mooring forces were used as input for the numerical model. This means different mooring layouts could be studied without carrying out additional model tests. By changing the harbour depth and the speed and dimensions of the passing vessel in the basin tests, and by varying the mooring layout in the numerical simulations, a complete series of tests was performed that provided the information the customer needed to continue the project.

Numerical tests

The effects of passing ships on moored vessels can also be investigated numerically. An investigation was made into the applicability of MARIN's in-house tools to predict passing ship effects. A distinction was made between the flow around the passing ship and the effect of this flow on the moored ship. When the passing ship sails under a drift angle, or when the

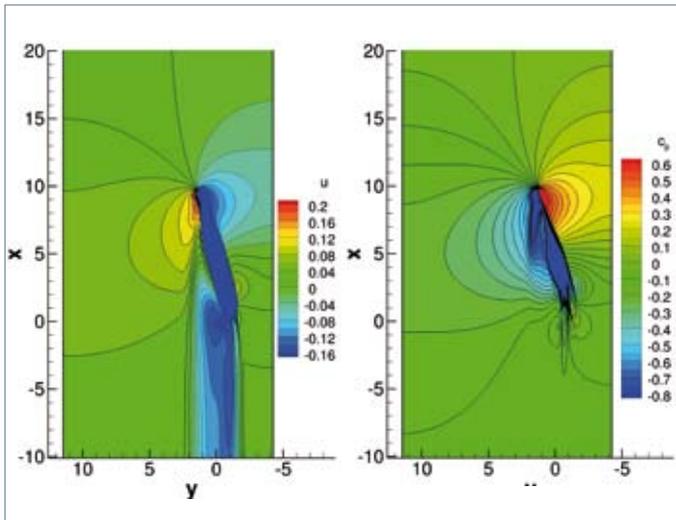
keel clearance is small, viscous effects are expected to be important. Therefore, the flow around the passing ship was analysed by the RANS (Reynolds Averaged Navier Stokes) code ReFRESKO, which accurately takes into account the viscous boundary layer and lift effects on the hull. The effect of the flow on the moored ship and the resulting forces were then analysed using the linear diffraction code DIFFRAC. For this purpose, a coupling between the two codes was made.

Passing ship model tests in the shallow water basin were then used for the validation of the coupled tools. This validation showed that viscous effects were indeed important in the case of drifting ships. Forces on the moored ship can be computed with satisfactory accuracy up to drift angles of at least 15% and a considerable improvement was obtained compared with a full potential flow approach. For small drift angles, a potential flow solution for the passing ship turned out to be sufficient.

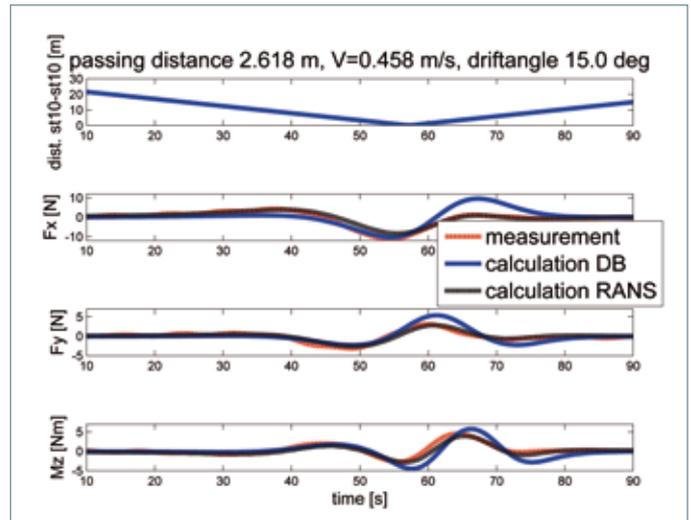
Computer modelling and full-scale monitoring

Existing ports have to accommodate ships with ever increasing sizes. ROPES, a new joint industry project, is developing reliable computer models to predict motions and the mooring loads of moored ships, and at the same time it is contributing to innovative, dynamic berth systems. Moored ships experience suction effects from passing ships and these increase in relation to the restriction of the waterway and the size and speed of the passing ship. The passing distance is obviously a critical variable. Passing events can threaten loading and discharging operations in both a safety-related and economic sense; excessive motions may lead to interruptions, damage and even to dangerous situations. ROPES is developing a numerical prediction method to quantify these effects for arbitrary ship and port geometries. To investigate the physics of the real world and to validate the numerical model, an extensive, full-scale monitoring campaign is being conducted by MARIN.

Earlier this year, the first series of full-scale measurements started at ECT's Delta Ter-



The velocity field (left) and pressure field (right) near the passing ship at 15 degrees drift angle



Comparison of mooring loads: full potential flow approach (DB, blue) RANS potential flow approach (RANS, black) measurements (red)

minal in Rotterdam. In close cooperation with the Port of Rotterdam and the pilots and boatmen, MARIN's Trials & Monitoring team instrumented the mooring lines with load cells and installed a motion sensor set on each vessel calling into the terminal around the clock for a period of two weeks. While building a database of passing vessels in the busy harbour of

the Maasvlakte, moored ships' motions, line loads, and metocean conditions were measured from the moment of arrival to departure. This first series of measurements spanned six ships being passed by more than 30 vessels, ranging from feeders to the very largest container carriers. While analysis continues, the ROPES monitoring campaign will continue at three more jetty lo-

cations, including a riverside mooring and a ship-to-ship offloading site. In phase II the potential of dynamic berthing systems, in which the mooring is dynamically controlled from shore, will be investigated and a control algorithm for such systems will be developed.

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