261. Container ships moored at the port of Antwerp: modelling response to passing vessels

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Thibaut Van Zwijnsvoorde [1], Marc Vantorre [1], Stefaan Ides [2]

[1] Ghent University, Belgium - [2] Antwerp Port Authority, Belgium

Statement

Safety of port operations is a key aspect in creating a positive environment for a port to expand in an increasingly demanding society. An important aspect here is the safe mooring of (large) vessels, currently being addressed in the PIANC WG 186. In order to improve the conditions for moored vessels, accurate modelling software is indispensable. The Maritime Technology Division of Ghent University has conducted many studies over the last years, focussing on the effect of passing vessels on moored ships.

Accurate modelling of the behaviour of moored vessels due to passing vessels is required for several reasons. At existing terminals, the safety of berthed vessels is maximized by optimising the mooring configuration of said vessels. When a new design vessel is expected at the berth, simulations are used to decide whether the vessel can moor safely given the existing boundary conditions, which are dominated by the passing ship traffic. As ports value their dynamic presence in the world market, quays are often reoriented, welcoming other design vessels. Mooring studies can help in pre-emptively assessing the new situation, in order to ensure safe conditions for the design vessel of interest, without the need to set speed limits for the passing vessels. Mooring simulations are also useful when designing new quays or even new harbour parts. This allows the designs to be optimised for a range of moored design vessels.

Abstract :

The safety of the moored vessel is affected by port and location specific factors. Some ports suffer from incoming swell, some from harsh wind conditions, others from the effect of passing vessels. In this paper, we focus on the effect of passing vessels on moored container vessels. Where the passing distances are rather small, e.g. due to the geometrical layout of the port, a passing vessel may cause the moored vessel to move along the quay during the ship passage. Large motions will eventually cause safety issues, both for vessel, quay infrastructure but most importantly for the crew members and workers. Reducing passing speeds in order to limit ship motions is a theoretical solution, however from point of view of safe navigation and/or efficient traffic management, this is not always a desired option.

In order to accurately model the behaviour of moored vessels, the software tool which is used for scenario analysis needs to be validated using model tests and/or full scale measurements. The Maritime Technology Division of Ghent University uses a two-step approach to model the effect of passing vessels. The forces acting on the moored vessel are calculated using the potential code ROPES [1] [2], which has been validated by model tests executed in the Towing Tank for Manoeuvres in Shallow Water (co-operation Flanders Hydraulics Research – Ghent University) in Antwerp, Belgium [3]. The motions of the moored vessels and the forces in lines and fenders are evaluated using the in-house software Vlugmoor, which solves second order motion equations in the time-domain. In order to validate the results, the modelled motions of the vessel are compared with GPS readings from full-scale measurements performed in the port of Antwerp. This has been done for various moored container vessels, monitoring their

movements during the entire stay at the berth. Several critical passing events are extracted from the data time series.

Subsequently, the software is used to study the mooring configuration of the observed vessels in detail. In a first stage, the position of the lines is optimised to minimise the longitudinal motions of the vessel along the quay, which is being observed as the dominating motion. All lines need to be positioned to maximize the longitudinal force component of the line, minimising the steepness and the angle with the quay wall in the horizontal plane. Secondly, the importance of having sufficient pretension in all lines is shown. The absence of pretension is most pronounced when nylon lines are used, as they show a non-linear stress-strain behaviour. If slack is present in the lines, there is a postponed reaction to the external force, causing heavier loading of the other lines. This leads to breaking of lines at lower external loads than expected based on conditions with optimal pretension. In a last part, the effect of important parameters, such as water depth, ship speed, passing distance, … on the behaviour of the moored vessel is shown.

[1] PINKSTER J.A.; PINKSTER, H.J.M., 'A fast, user-friendly, 3-D potential flow program for the prediction of passing vessel forces, PIANC world congress, San Francisco, 2014.

[2] PINKSTER, J.A., 'The influence of a free surface on passing ship effects', int. shipbuild. Progr, 2004.

[3] TALSTRA, H.; BLIEK, A.J., 'Loads on moored ships due to passing ships in a straight harbour channel, PIANC world congress, San Francisco, 2014.