MOTIONS OF MOORED VESSELS DUE TO PASSING VESSELS: FULL-SCALE MEASUREMENTS AT A CONTAINER TERMINAL IN THE PORT OF ANTWERP

by

S. Ides[1], C. Pauwels[2] and P. Torfs[3]

EXTENDED ABSTRACT

The North Sea terminal (Figure 1) is a busy container terminal in the port of Antwerp which is located in the tidal river Scheldt along the navigation channel. At this terminal multiple deep-drafted container vessels in the range of Neo Panamax up to Ultra Large Container Vessels berth on weekly basis. On the other hand, all seagoing vessels coming to and leaving the port of Antwerp pass this terminal. All passing vessels cause a displacement of the water resulting in forces working on the moored vessel. The size of these forces are dependent on the water level, the passing speed, the passing distance as well as the dimensions of the passing and the moored vessel (Talstra et al, 2014). The mooring lines as well as the fenders will try to absorb the forces working on the moored vessel, however the latter one will experience some motions due to the elasticity of both mooring lines and fenders.

Figure 1: Port of Antwerp – North Sea terminal (north) and Europe terminal (south) located along the river Scheldt. The Zandvliet-Berendrecht lock complex to the non-tidal port area on the right bank is also visible on the figure.

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[1] Antwerp Port Authority, Port Area Development, Stefaan.Ides@portofantwerp.com
[2] Antwerp Port Authority, Port Area Development, Cynthia.Pauwels@portofantwerp.com
[3] Antwerp Port Authority, Vessel Traffic Management, Peggy.Torfs@portofantwerp.com

The North Sea terminal was designed and built in the 1990's. However, due to economies of scale in the container vessel industry, the sizes of the seagoing vessels have increased a lot during the last 2 decades resulting in a situation which is different from the design phase. As such, the Antwerp Port Authority executed a full-scale measurement campaign at the North Sea terminal, the terminal in the port of Antwerp which is most exposed to ship-ship interaction effects. During a period of 3 months the motions of all moored container vessels larger than the Panamax class at this terminal where measured using 2 dGPS instruments mounted on board of the vessel. All information about the vessels passing the terminal, as well as the wind and the current conditions were monitored.

From these measurements, it was seen that the horizontal motion of the moored vessel parallel to the quay wall was dominant over all other motions (both translational and rotational). Analysis of this large dataset also confirmed the relationship of the magnitude of the motion of the moored vessel with the passing speed, the passing distance as well as the dimensions of the passing and the moored vessel. However, besides these parameters, the properties of the moored vessel (the mooring configuration in particular) also seemed to be a crucial factor. First of all the importance of pre-tension in the mooring lines, which is challenging to obtain at all times in a tidal environment where it is not allowed to use auto-tension, was clearly seen. A typical effect of slack lines is not only an important increase in magnitude of the motion but also a lack of damping of the vessel's motion, resulting in many back and forth oscilations of the moored vessel before it returns to a rest position. Secondly a clear difference in observed motions of the moored vessels was seen in relation to the quality of the mooring lines being used. Where the minimum breaking load of the mooring lines was always in agreement with the guidelines set out by IMO, there is no such regulation about the elasticity of the mooring lines. As such, a large difference in elasticity has been found, where a larger elasticity clearly results in larger motions of the moored vessel. Even with good pre-tension on the mooring lines, some vessels with mooring lines with an elongation at break of more than 30% showed rather large motions during some passing events.

In order to guarantee the safety of the terminal operations at all times, it was investigated whether the so-called ShoreTension system could minimize the motions of the moored vessels equipped with elastic mooring lines. The ShoreTension system is a dynamic mooring system developed to assist large container vessels in the port of Rotterdam to stay safe at the quay wall during extreme wind loads. The system consists of a hydraulic piston which guarantees a minimal tension in the mooring lines at all times. It is used in combination with stiff Dyneema mooring lines which are applied in addition to the regular mooring lines. Since it's effectiviness was never tested for ship-ship interaction events, in situ tests were performed at the North Sea terminal in the Port of Antwerp. During a period of 3 months, the motions of moored vessels equipped with the ShoreTension system were monitored. Different configurations have been tested in order to find out what is the most optimal configuration for ship-ship interaction effects. The full-scale measurements have proven that the ShoreTension system can help in reducing the motions of the moored vessels considerably, however guaranteeing the pre-tension in the conventional mooring lines at all times remains a necessary condition for safe mooring even with the ShoreTension system.

The data of the in situ measurements was used to validate the mooring simulation software Vlugmoor, which is developed by the Ghent University (Van Zwijnsvoorde et al, 2018).

REFERENCES

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