CONTAINER SHIPS MOORED AT THE PORT OF ANTWERP: MODELLING RESPONSE TO PASSING VESSELS.

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EXTENDED 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, the focus lies 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 (Pinkster, 2004)(Pinkster, 2014). The motions of the moored vessels and the forces in lines and fenders are evaluated using the in-house software Vlugmoor (Van Zwijnsvoorde and Vantorre, 2017), 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, at the location of the North Sea Terminal (Figure 1, with indication of passing trajectories). The moored vessel discussed in the paper is a Neo-Panamax container vessel, carrying around 13000TEU. Several critical passing events are extracted from the data time series. Figure 2 shows the registered ship motion along the quay, when an oil tanker passes along trajectory 2 (Figure 1).

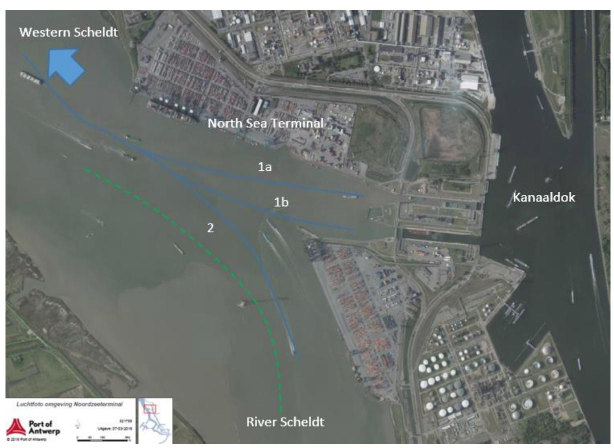

**Figure 1 : Port Of Antwerp ; Location North Sea Terminal; Three examples of passing trajectories (blue) and edge of navigational channel (green dash).
– image courtesy of Antwerp Port Authority**

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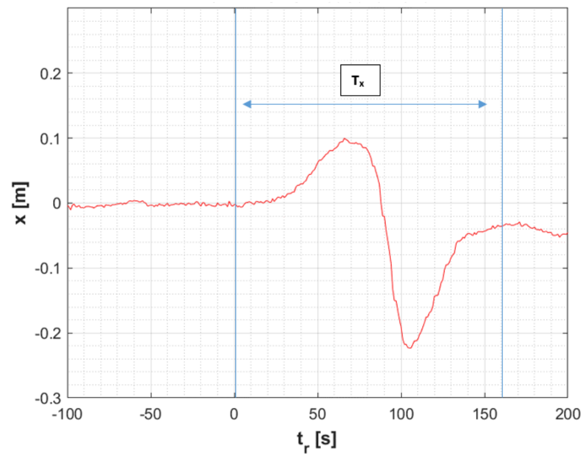

Figure 2 : GPS registration longitudinal motion of moored Neo-Panamax container vessel with passing oil tanker.

Subsequently, the software is used to study the mooring configuration of the observed vessels in detail. A first attempt is presented to evaluate the performance of the mooring configuration and allow comparison between different configurations, based on so-called efficiency parameters. The starting point is the analysis of the individual mooring line, which can be described by its angles (α, β) and line length ℓ, which is the sum of the line section between fairlead and bollard on shore and the segment between fairlead and winch on board (Figure 3).

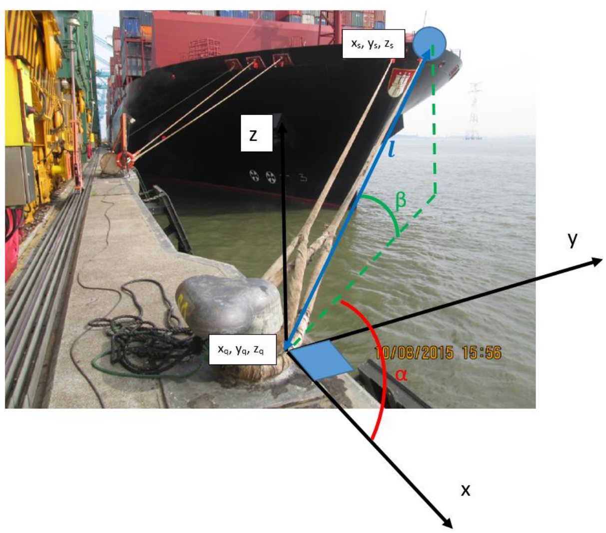

Figure 3 : Definition line angles α and β and the length of the line section between bollard and fairlead (l).

Based on α, β and ℓ, efficiency parameters in the horizontal plane (longitudinal and transversal direction), are obtained, based on force and line elongation considerations.

$$e_{Xi} = \cos^2 \beta_i \cdot \cos^2 \alpha_i \cdot \left(\frac{\ell_i}{\ell_{ref}}\right)^{-1} \quad (1)$$

$$e_{Yi} = \cos^2 \beta_i \cdot \sin^2 \alpha_i \cdot \left(\frac{\ell_i}{\ell_{ref}}\right)^{-1} \quad (2)$$

Based on these efficiencies, the positions of the lines can be changed, in order to improve the efficiency of the lines, for the main external load direction. For a passage event at a quay wall, the longitudinal efficiency (e_{Xi}) should be maximised. In a next step, e_{Xi} and e_{Yi} are combined into four efficiency parameters, expressing the capability of the mooring arrangement to counteract longitudinal disturbances in both directions, and lateral disturbances on the fore and aft side of the ship. These efficiency parameters can be used to assess and optimise the mooring plan.

$$e_{Xp} = \sum_{i=1}^{n_{\alpha<90}} \cos^2 \beta_i \cdot \cos^2 \alpha_i \cdot \left(\frac{\ell_i}{\ell_{ref}}\right)^{-1} \tag{3}$$

$$e_{Xn} = \sum_{i=1}^{n_{\alpha>90}} \cos^2 \beta_i \cdot \cos^2 \alpha_i \cdot \left(\frac{\ell_i}{\ell_{ref}}\right)^{-1} \tag{4}$$

$$e_{Yf} = \sum_{i=1}^{n_f} \cos^2 \beta_i \cdot \sin^2 \alpha_i \cdot \left(\frac{\ell_i}{\ell_{ref}}\right)^{-1} \tag{5}$$

$$e_{Ya} = \sum_{i=1}^{n_a} \cos^2 \beta_i \cdot \sin^2 \alpha_i \cdot \left(\frac{\ell_i}{\ell_{ref}}\right)^{-1} \tag{6}$$

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