Document title	Article 005: Passing Vessel Effects
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Abstract

In offshore and port engineering, the safe and reliable design of mooring systems is essential for ensuring the operability of floating structures such as tankers, FPSOs, LNG carriers, and offshore support vessels. Among the various external influences considered in a dynamic mooring analysis—such as wind, waves, and current—the effect of passing vessels is often underestimated but can be critical. Passing ships generate transient hydrodynamic forces on moored vessels, which may induce significant line tensions and vessel motions. Correctly accounting for these effects is therefore an important step in ensuring both safety and operational continuity.

1. Passing vessel effects

1.1. Introduction

When a ship sails near a moored vessel, its hull displaces water, creating pressure differences and flow fields in its wake. This results in:

- Suction forces and sway motions as water is drawn toward the passing vessel's hull.
- Surge effects due to the pressure gradient ahead and behind the moving ship.
- Yaw and roll responses of the moored vessel caused by asymmetric flow fields.

The intensity of these forces depends on several factors, including:

- Size and speed of the passing vessel.
- Distance and orientation between the passing and moored vessel(s).
- Water depth and channel geometry.
- Hull forms of both vessels.

These short-duration but potentially high-impact events can stress mooring lines beyond their intended operational envelope.

1.2. Background

Ignoring passing vessel effects can lead to an underestimation of line loads and vessel excursions. This has practical implications in terms of safety, operations and design. Excessive mooring loads increase the risk of line failure, leading to vessel drift or collision. Terminal downtime, cargo transfer interruptions, and regulatory non-compliance can result from unexpected vessel motions. Accounting for passing ships allows engineers to avoid over-conservative or under-designed mooring layouts, leading to cost-efficient solutions.

For busy ports, waterways with high traffic density, or offshore terminals located near shipping lanes, incorporating passing vessel effects is not optional but a necessity.

1.3. Methodology

There are several approaches to representing passing vessel loads in a numerical mooring analysis. For preliminary design and quick assessment regression models from experimental data can be used. This provides estimates of surge, sway and yaw forces as functions of vessel size, speed, and passing distance.

One example is provided in [ref 1], where normalized forces and moments are given. The user can then construct time histories by including appropriate values for passing ship speed/distance, current speed, under keel clearance, and ship dimensions. Additionally in this article, a narration of the passing ship effect of this figure are described.

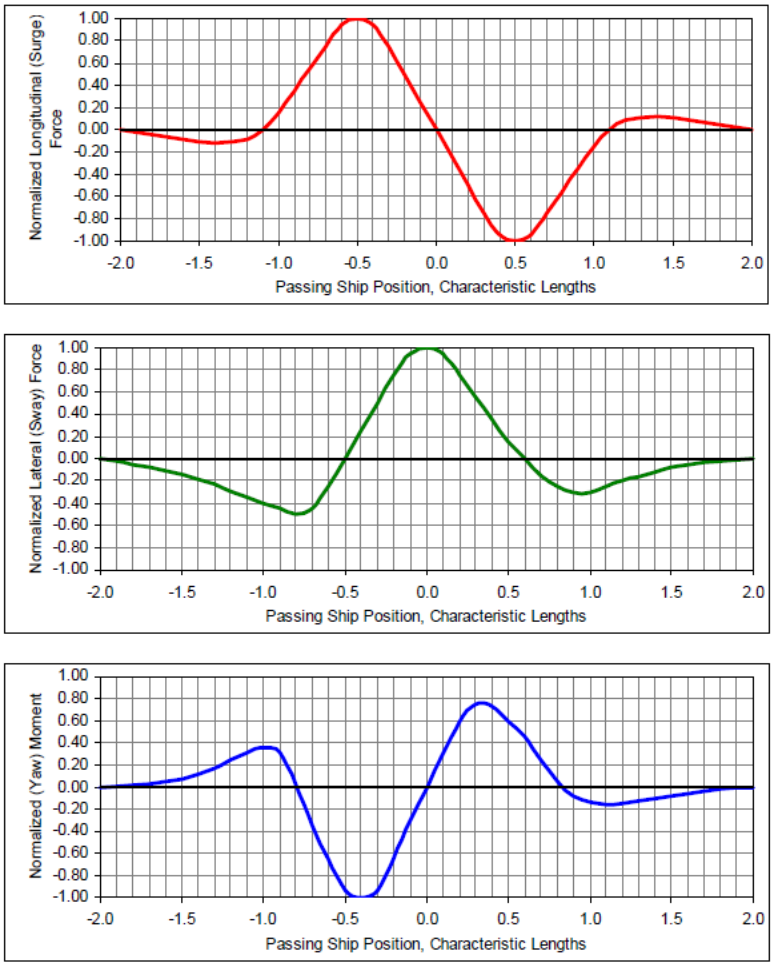

Figure 1-1: Example regressional model [ref 1]

A regressional model is only valid within the boundary conditions applicable to the data itself. Another method that can be used to obtain project specific time history of passing vessel forces is a boundary element method (BEM). BEM can be used to solve the flow field around both vessels. This can capture site-specific such as shallow water or restricted

channels. Using a BEM method requires additional computational effort. A panel method is used here to represent the 3D unsteady potential flow. Fluids can be unbounded for deep unrestricted water, depth-limited for shallow water and optionally restricted by channel sides as shown in Figure 1-2. Additionally, velocity fields and pressure fields around bodies can be visualized to provide insight into the flow behavior and the way this influences the interaction forces.

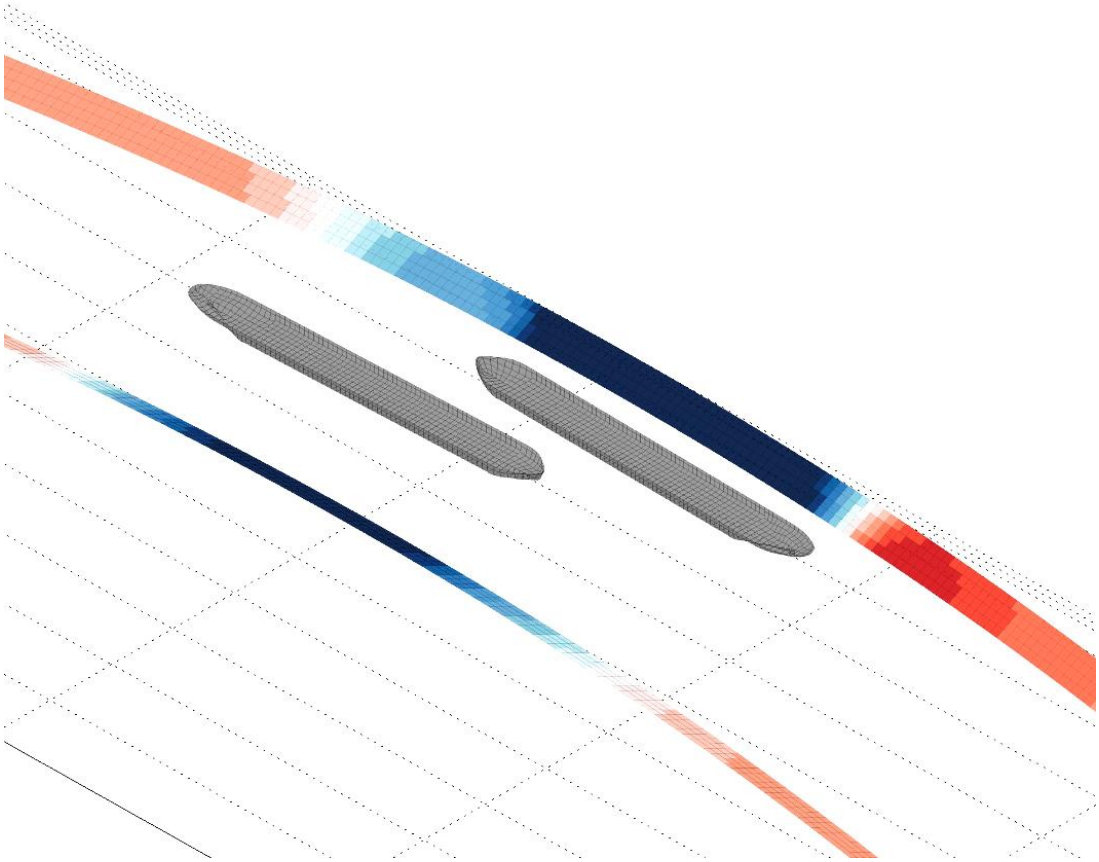

Figure 1-2: Schematization of a passing and moored vessel within a confined channel

Once the method has been selected, the derived time series of forces are applied as external loads in numerical mooring assessment software. The model then can calculate mooring responses under combined environmental and passing ship effects. From these results operational limits can be defined. Additionally, regulations (e.g. speed limits and distances) can be formulated.

1.4. Service we provide

Leadline Maritime schematizes ships and channel boundaries from technical drawings, depth contour lines and ship body plans. The movement of the ship is described by interpolation of position, heading and velocity along a predefined trajectory. Passing vessel

simulations can then be carried out. Results of simulations are time-series of forces and moments acting on bodies in the flow, which can be applied further in computational assessments. The method itself uses a frequency domain method, but the output are time series, as the position of either vessel changes in time. There is no interaction between results computed at a previous time and position instance throughout the computation.

1.5. References

1. The effect of passing ships on moored ships. J. Flory. Tension Technology International, LLC. September 10-11, 2002. Long Beach, CA.