Side-by-side mooring in the 4th Petroleumhaven

Dynamic mooring analysis

Background

Delta Marine Consultants bv (DMC) is assisting Shell Global Solutions International (SGSI) to investigate the feasibility of side-by-side mooring at three berths in the 4th Petroleumhaven in Rotterdam. The 4th Petroleumhaven is located to the south of the Calandkanaal which is a continuous channel. Apart from wind forces, moored vessels will also encounter forces from passing ships.
These berths have been designed and are being used for conventional single ship mooring. Allowing a second ship to berth side-by-side to the original ship at the jetty might require an upgrading of the jetty facilities (berthing dolphins, fenders, quick release hooks).

Objective

The objective of the study is to determine the motions and mooring forces of the side-by-side moored vessels at the three berths in the 4th Petroleumhaven. Planned side-by-side mooring situations were investigated under the influence of characteristic mooring, wind and passing ship situations.

Type of project	Dynamic Multi-Body Mooring Study
Location	Rotterdam, The Netherlands
Client	Delta Marine Consultants bv / Shell Global Solutions International
Period	November 2008 – November 2009

Figure 1: Location of the 4th Petroleumhaven in Rotterdam (courtesy of Google Earth)

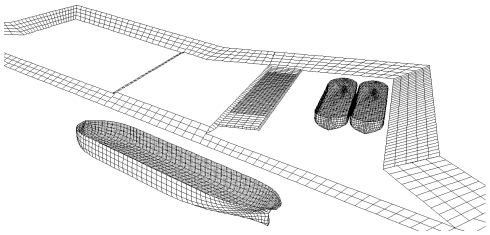
Project description

Alkyon
Hydraulic Consultancy & Research

A2184/A2420

Study approach

The multi-body dynamic mooring simulations were carried out with Alkyon's mathematical model SHIP-MOORINGS MULTI-BODY. The simulations took into account the forces on the ships due to operational wind conditions, passing ships on the Calandkanaal as well as the interaction forces between the ships.
Conservative mooring and passing conditions were chosen (small under keel clearance, high passing speeds and low passing distances) to determine maximum motions and forces in the mooring system.



The mathematical model DELPASS was used for the calculation of the excitation forces on the moored ships caused by passing ships (see Figure 2). This model uses an applied double-body flow method to determine the effects of the passing ship at the location of the moored ship (inclusive free surface effects).

Figure 2: Schematisation example for the calculation of the passing ship forces

The dynamic, non-linear response of the moored vessels (6 degrees of freedom) and the mooring system on the applied passing ship and environmental forces was calculated with Alkyon's numerical model SHIP-MOORINGS MULTI-BODY.
The simulations were carried out considering the hydrodynamic interaction between the bodies and between body and bottom. The hydrodynamic characteristics of the vessels are based on the 3-D diffraction theory and were determined with DIFFRAC, a model supplied by MARIN that uses a panel method and Green's functions.

The jetty layout was schematised including the planned position of the quick release hooks and fenders. The mooring lines and fenders were schematised using non-linear load-deflection and load-elongation characteristics.

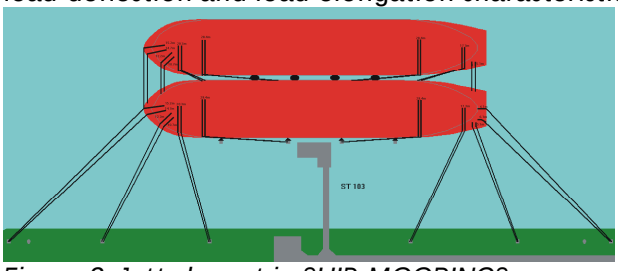


Figure 3: Jetty layout in SHIP-MOORINGS

Results

The results showed that the loads induced by the passing ship are considerable higher than the loads induced by the wind. Still most of the planned side-by-side mooring scenarios are feasible. For some tested scenarios the loads in the mooring system and/or the ships' motions are exceeding limiting criteria.

Applied tools

SHIP-MOORINGS MULTI-BODY
DIFFRAC
DELPASS

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