



DHI SOLUTION

# ENABLING SAFER VESSEL BERTHING AND OPERATIONS

## Advanced tool for modelling motions and forces of moored vessels

### A RAPIDLY EXPANDING MARITIME SECTOR

The rapid expansion in global maritime trade has resulted in an explosive growth in ship traffic. This has posed new and often complex challenges to both harbour designers and port operators around the world. Increasing vessel sizes, introduction of exposed offshore berthing facilities and escalated usage of existing port infrastructure are today's realities. In order to achieve operational safety and minimise downtime, while ensuring cost efficiency, innovative new solutions are the need of the hour.

### IT'S A QUESTION OF SAFETY AND ECONOMY

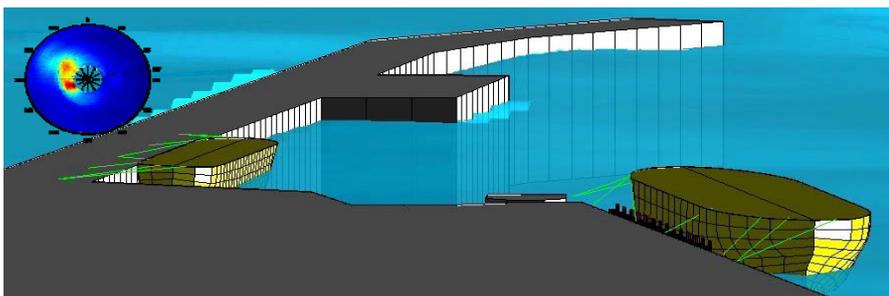
Modern maritime transport systems require minimum time durations for loading and unloading cargo in ports and terminals. This requirement is often restricted by ship movements at quays. If the ship movements are too large, cargo handling operations will slow down or even cease. Ultimately, damage to the ship and port installations may occur.

There is a rising need for fast cargo handling operations without delays caused by ship motions. It has become imperative to consider this requirement to minimise downtime and maximise safety.

### MIXED SEA-STATES AND LOW-FREQUENCY WAVES INDUCE EXCESSIVE MOTIONS OF MOORED VESSELS

A large number of recent port developments are situated along exposed open ocean coasts in areas dominated by energetic and concurrent wind-wave and swell components from multiple directions. These conditions cause complex and potentially hazardous conditions for moored vessels and floating structures.

Moreover, long period infra-gravity waves have a recorded history of causing low-frequency oscillations in harbours, resulting in large vessel motions and associated unacceptable downtime.



WAMSIM can be used to simulate moored vessel motion in enclosed harbours exposed to multi-directional sea states.

### SUMMARY

#### CLIENT

- Port and terminal authorities
- Port designers and operators
- Developers of floating structures
- Contractors
- Oil & gas operators

#### CHALLENGE

- Hazardous loading conditions
- Costly downtime
- Possible human safety issues and damage to equipment
- Delayed installation and commissioning

#### SOLUTION

The WAMSIM tool simulates wave-induced motion of single or multiple moored floating structures in the time-domain in response to complex flow fields, such as those induced e.g. by passing vessels or complex mixed sea-states. This allows operators to adopt effective mitigation measures early in the feasibility and design process.

#### VALUE

- Faster, more effective and cost-efficient tests
- Optimised port and floating/mooring system design
- Safe and efficient cargo handling operations
- Easy interpretation by decision makers

#### CLIENT TESTIMONIAL

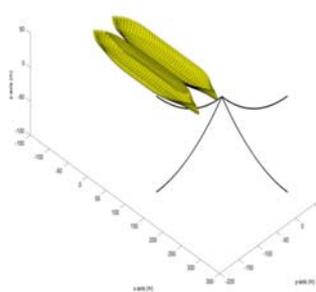
*"The results were faster, more accurate and allowed us to test more scenarios than physical modeling would allow. The project allowed the Corporation to critically assess a key strategic direction for the port."*  
Robert Hancock, Port of Brisbane

Preventing dangerous conditions at vessel berths and minimising costly downtime require a detailed description of the wave transformation processes as well as the associated vessel responses. In order to introduce cost-effective mitigation alternatives, it is advisable to address such concerns early in the design phase.

**OFFSHORE VESSEL MOORING TO FLOATING STRUCTURES**

Recent years have seen increased, application of large-scale Floating LNG (FLNG) processing facilities as well as floating re-gasification vessels. The offloading process between such facilities and a moored tanker often takes place in unprotected areas and is clearly restricted by the operation of the LNG offloading arm. Detailed knowledge of the relative vessel motions and mooring line forces is required, to make these facilities reliable and viable solutions.

Investigations of hazardous operational sea states and optimisation studies of mooring layouts will have to account for the interaction of such multiple moored structures in energetic ocean sea states.



*WAMSIM simulates the moored multi-body vessel interaction in open oceans including the effect of wind, current and wave induced drift forces*

**PASSING VESSELS CAUSE DANGEROUS SURGE MOTIONS AT NEARBY FLOATING STRUCTURES**

Large vessels moving in shallow water environments create transient displacement waves or draw-down. These waves can be troublesome to vessels or floating structures moored nearby. The phenomenon becomes particularly problematic for large vessels moving in constrained areas such as rivers and narrow estuaries. The vessel induced waves can produce long-period surge motions of several metres, leading to hazardous conditions at the berth.

As the size and number of ships increase at major ports around the world, there is a call for regulations dictating minimum vessel-passing distances and speed limits. Also, improvements to the mooring system of the affected vessels can be required in order to increase operational safety and performance of the moored vessel and reduce downtime.

**NUMERICAL MODELS ARE OFTEN CHEAPER AND FASTER THAN PHYSICAL MODEL TESTS**

Traditionally, physical model tests in large test basins are used to assess loads on and responses of moored vessels. In many cases, however, numerical modelling is a faster and cheaper alternative or supplement to physical modelling.

Therefore, DHI has developed WAMSIM: an advanced numerical modelling system that makes it possible to carry out these types of hydraulic studies more efficiently and cost-effectively. WAMSIM also speeds up the assessment process and allows for a wide range of variables to be considered.

**WAMSIM: UNITING THE BEST OF TWO WORLDS**

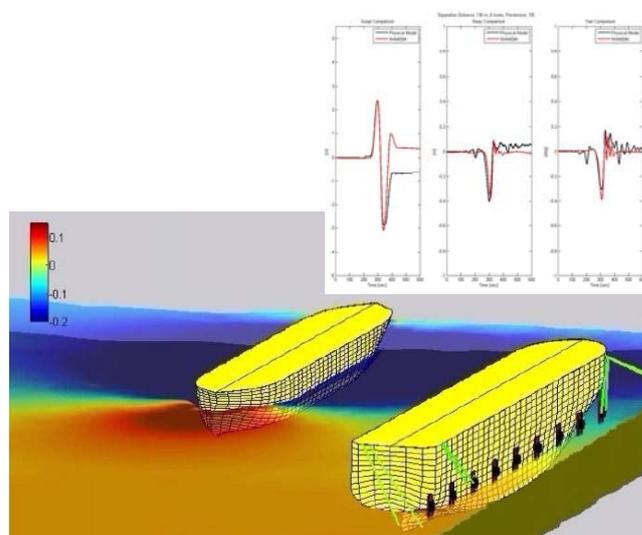
WAMSIM simulates the motion of moored vessels and floating structures in the time domain. Through an innovative and efficient coupling method, WAMSIM unites the best of two worlds: (1) MIKE by DHI's wave and hydrodynamic models serve as the wave/flow simulation engine. (2) WAMIT® by WAMIT Inc. is a vessel response model used for calculating the frequency response functions of the floating structures. The effect of breakwaters and other port structures on the wave field is included in the MIKE by DHI model.

The WAMSIM tool transforms the information delivered by WAMIT® and combines it with information delivered by MIKE by DHI modelling to simulate the dynamic motions of a moored vessel for all six degrees of freedom.

**EASILY UNDERSTANDABLE RESULTS**

This moored vessel response simulation package is DHI's state-of-the-art tool for the analysis of moored floating structures subject to wave, current and wind forcing, whether located in ports, coastal or offshore areas.

WAMSIM delivers highly accurate results, which can easily be interpreted by decision makers. The results of the simulations are typically presented as time-series of motions for surge, sway, heave, roll, pitch and yaw and as forces in the mooring lines and vessel diffraction forces. The waves and hydrodynamic and vessel motion models are verified against data from physical model tests, carried out in DHI's physical model test facilities and elsewhere. Also, WAMSIM will supply you with 3D animations of the results for easy visualisation and presentation.



*Draw-down caused by a passing vessel can cause serious problems to nearby moored vessels. WAMSIM allows for potential impacts to*

Contact: **Henrik Kofoed-Hansen** [hkh@dhigroup.com](mailto:hkh@dhigroup.com) • **Simon Brandt Mortensen** [sbm@dhigroup.com](mailto:sbm@dhigroup.com)  
 For more information visit: [www.dhigroup.com](http://www.dhigroup.com)