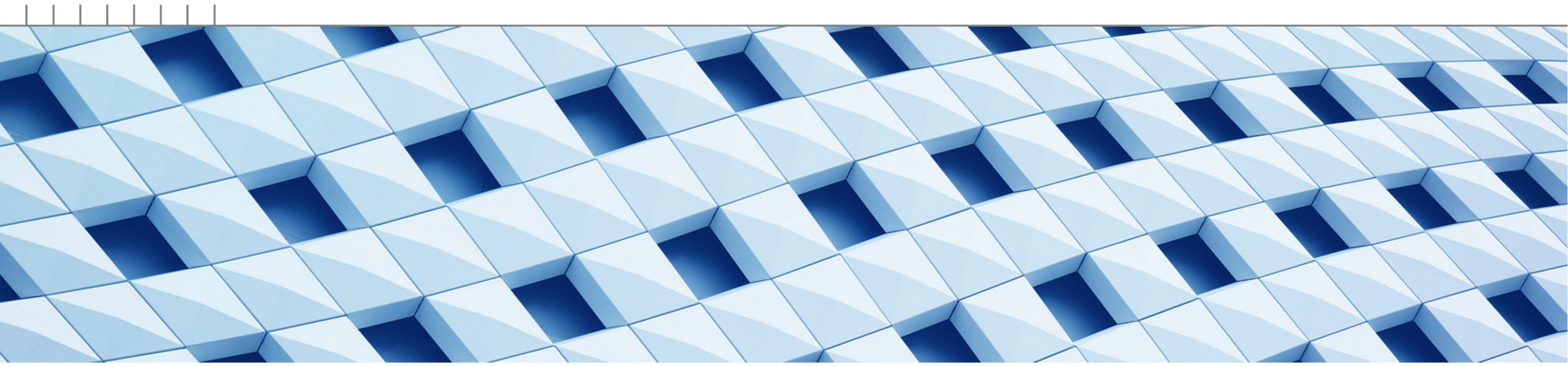

DIFFRAC

Calculation of wave loads and motions using 3-D potential theory including wave diffraction

DIFFRAC is a wave diffraction program capable of calculating the first-order wave loads and motion responses of multi-body free floating or moored structures in regular waves, including their hydrodynamic interaction. DIFFRAC is also capable of calculating the mean and low-frequency second-order wave drift loads. The program is applicable to both shallow and deep water and has been validated against many physical model test results.

References

- Buchner et al. “Numerical Multiple-Body Simulations of Side-bySide Mooring to an FPSO”, Proc. of IOPEC2001.
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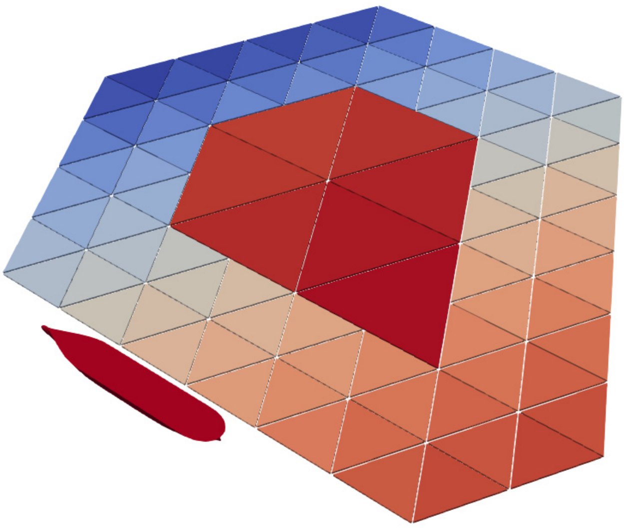
- Pauw, Huijsmans and Voogt; “Advances in the Hydrodynamics of Side-by-side Moored Vessels”, Proc. of OMAE2007.
- Pinkster, J.A.; “Low Frequency Second Order Wave Exciting Forces on Floating Structures”, NSMB Publication No. 650, 1980.
- Waals, O.; “The Effect of Wave Directionality on Low Frequency Motions and Mooring Forces”, Proc. of OMAE2009.
- Bunnik et al.; “Hydrodynamic Analysis for Side-by-Side Offloading”, Proc. of ISOPE2009.

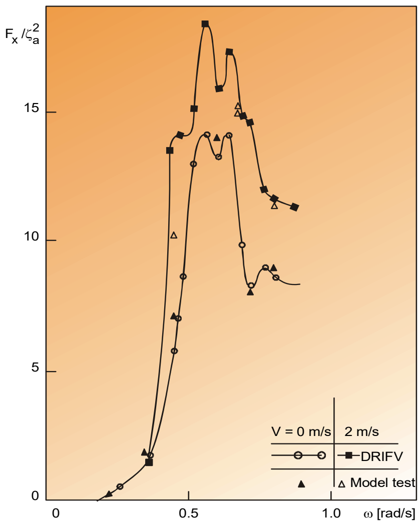
First-order wave loads and motions

DIFFRAC is based on a three-dimensional source distribution technique for the solution of the linearised velocity potential problem. For this approach the fluid is assumed to be inviscid, homogeneous, irrotational and incompressible. DIFFRAC computes fluid pressures and wave loads on the basis of the velocity potential around the floater(s), given as a scalar function in space and time. The effect of current can also be considered.

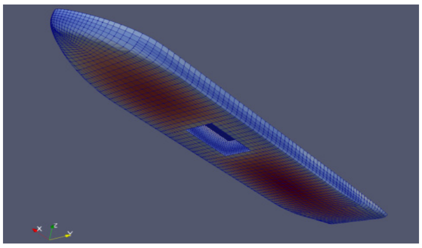
For the computations, the mean wetted part of the hull of the vessel(s) is approximated by a number of plane elements. Each element represents a distribution of source singularities, each of which contributes to the velocity potential describing the fluid flow. The rigid lid method is used to suppress the effect of irregular frequencies. A damping lid may be used to damp resonant water motions, for example in the gap between side-by-side moored vessels.



Geometry with LNGC moored to a multi-body floating island (88 bodies in total)



Effect of current / forward speed on drift force on 200 kDWT tanker



Pressure distribution on a drillship

Restrictions

The method is based on inviscid flow theory, which excludes the effect of boundary layers, flow separation and in a general sense the effect of viscosity. Consequently, the motions for which damping is dominated by viscous effects are usually overestimated, as well as wave elevations in the gap between multi-bodies or in moonpools. However, the user can apply additional damping to a body or on the free surface to model the effect of viscosity. A source distribution is used. Therefore flat elements (bilge keels, heave plates) cannot properly be modelled.

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Second-order wave loads

DIFFRAC can also compute the mean second-order wave drift loads in regular multidirectional waves, and the low frequency second-order wave drift loads in regular multidirectional wave groups respectively for six degrees of freedom on bodies of arbitrary shape. The second-order wave drift loads are important for the design of mooring systems for floating offshore structures, dynamic positioning systems or control systems for semi-submersibles transiting at low drafts.

Computations of wave drift loads can be carried out for structures with arbitrary shaped underwater hull geometries. Successful computations have been carried out for, amongst others, diving support vessels, tankers, barges, semi-submersibles, submarines, tension leg platforms and drillships.

The computations are based on direct integration of fluid pressures acting on the wetted part of the hull of a structure. The fluid pressures are obtained from Bernoulli's equation. The first-order vessel motions and first-order velocity potentials describing the flow around the vessel are required in order to compute the second-order wave drift loads.

Input

- Structure's geometry (body plan)
- Position of centre of gravity
- Mass matrix
- Water depth
- Wave frequencies and directions
- Current speed and direction

Output

- Hydrodynamic reaction forces and moments, expressed as added mass and damping coefficients due to the structure-fluid interaction
- First-order wave exciting forces and moments including the diffraction effects of the waves on the structure(s)
- Response amplitude and phase operators can be obtained from the linearised set of equations of motion, where the first-order wave exciting forces and moments together with the added mass and damping coefficients are used
- Total pressure and velocity distribution, including motion and wave effects, needed for the strength analysis
- Quadratic Transfer Functions of the drift forces and moments. These transfer functions are dependent on two frequencies which correspond to the frequencies of the two regular wave components present in a regular wave group, possibly propagating in different directions. These forces can be used to compute the mean drift loads and spectra of drift loads in unidirectional or short-crested irregular seas.