MARIN

Challenging wind and waves

Linking hydrodynamic research to the maritime industry

Computational methods for moving and deforming objects in extreme waves (Joint Industry Project)

ComMotion JIP

"ComMotion" is a joint industry project focusing on the development of a fast and efficient CFD method for predicting extreme wave loads on offshore structures that are moving and deforming interactively with waves.

Background and motivation

The offshore industry, MARIN and the Universities of Groningen and Delft have worked together successfully in the development of the Volume of Fluid method ComFLOW to study complex free-surface flows around offshore structures. Important aspects have been studied, implemented and validated like:

- Sloshing in LNG containment systems
- Air entrapment during wave impacts ("cushioning")
- Wave run-up and deck impacts on semi-submersibles and TLPs

In the most recent Joint Industry Project ComFLOW-3, additional steps were made by including new functionalities to the ComFLOW program, such as:

- Modelling of viscous flow effects
- Local grid refinement
- Advanced wave propagation algorithms
- Absorbing boundary conditions for irregular and short crested waves
- Modelling of mooring lines and their influence on floater motions

A step towards improving the computational efficiency was made by applying parallelisation to the Poisson solver.

During these developments, new questions and demands from participating companies and the offshore industry arose: significant speed-up of algorithms is needed to advance the usability of ComFLOW to more and more complex engineering applications; new and improved functionalities are needed to achieve results in a wider range of applications. The ComMotion JIP aims to meet these demands by developing and improving functionalities that increase computational accuracy and efficiency, and by incorporating new algorithms for interactively moving bodies, hydroelasticity and accurate steep irregular wave generation.

The joint industry project runs parallel to the identically-named research project ComMotion, which is financed by the Dutch government and supports 2 PhD students, a post-doc and validation model tests. The results of this research project are made available to the ComMotion JIP.

Examples of new ComFLOW application areas. Left: test with free fall life boat (from: www.verhoef.eu). Right: offshore monopile platform in heavy weather (from: www.flyingfocus.nl).

Objectives and scope of work

The objective of the ComMotion JIP is:

> "To further improve, develop and validate the ComFLOW program for complex free-surface flows in the offshore industry, and to extend its usability to more complex and a wider range of engineering applications by improved functionality and speed-up of the algorithms."

The following issues are therefore addressed in the ComMotion JIP:

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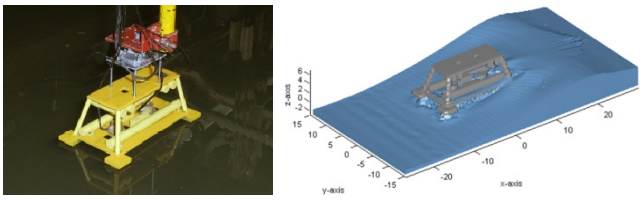
New functionality

- Modelling of hydroelastic deformation and its effect on wave loading (e.g. wave impacts on deck structures, free fall lifeboats and monopiles)
- Adaptive grid refinement to enable the detailed study of moving local flow problems by using a locally very dense grid that moves with the area of interest (e.g. flow around bilge keels, wave impacts on moving structures)
- Possibility to model multiple interactively moving bodies (e.g. side-by-side offloading)

New functionalities will be validated using fundamental model tests (2D impact on a flexible wall) and model tests for industrial applications (free fall lifeboat, flexible offshore wind turbine tower, installation of subsea structure through splash zone)



Validation of wave loading during an operation through the splash zone. Left: test set-up with instrumented model (MARIN shallow water basin). Right: ComFLOW simulation.

Improvement of present functionality

- Parallelisation of the complete ComFLOW program code, for usage with either multi-core PCs or with a distributed memory system
- Modernization and extension of pre- and post-processing (e.g. XML based input, improved error handling, development of a geometry pre-processor, compatibility with state-of-art visualisation software)
- Implementation of a more efficient solver for simulations with absorbing boundary conditions
- Better algorithms for the generation of steep irregular (short crested) waves

Project deliverables

The deliverables of the ComMotion JIP will be:

- Annually, a new release of ComFLOW (and manual) including the extensions made during the project up until that moment
- A report with a description and results of the validation model tests
- A validation report showing the results of ComFLOW versus the results of the new validation model tests
- A benchmarking report showing the results of ComFLOW versus the results of the existing suite of validation model test data
- A benchmarking report showing the results of ComFLOW versus results of other (commercially available) CFD software packages
- PhD theses of the PhD students with detailed descriptions of the background of the method and the extensions which will be made during the project
- At the end of the project, a workshop will be organised where the participants can learn to work with the new version of ComFLOW

Schedule

The project will have a 4-year duration and starts in the autumn of 2014. JIP progress meetings will be held biannually during the FPSO JIP week.

Participation fees

The following participation fees apply:

Company type	Non ComFLOW-3 participant	ComFLOW-3 participant
Oil companies	125,000	75,000
Others	80,000	50,000

Total budget: 1.5 MEuro (including 820KEuro research project financed by the Dutch government)

Organisation and contact

The project will be conducted in close coorporation with the Universities of Groningen and Delft, the ComFLOW project team (RUG, TUD, FORCE Technology Norway, Deltares and MARIN) and all JIP participants. MARIN will act as JIP manager. All participants will be represented in the ComFLOW user group, with meetings every 6 months.

For more information please contact MARIN:

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