Validation of a roll decay test of an offshore installation vessel using OpenFOAM

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ABSTRACT

Floating structures are prominently present in coastal and offshore regions, e.g. ships, pontoons, barges and pipelines. In the future, it is expected that innovative floating structures such as wave energy converters and wind turbines will be installed for renewable energy production. All these structures need special installation vessels such as a heavy lift jack-up vessel or a heavy lift floating installation vessel. The workability of these vessels depends on the wave, current and wind loading. Not only the forcing is of large importance for the installation of structures but also the response to the environmental loads needs an accurate quantification.

Nowadays, simplified radiation-diffraction models such as linear potential flow solvers based on boundary element methods (BEM) are used to simulate vessels. These models are not capable in resolving nonlinear, viscous and turbulent effects and waves breaking on a vessel. Computational Fluid Dynamics (CFD) is selected to overcome this problem. Simulations of the two-phase flow field are performed by solving the incompressible RANS equations, with a conservation equation for the Volume of Fluid (VoF). The mesh motion is organised by either using mesh morphing, sliding meshes or an overset method as implemented in OpenFOAM [1].

In this work, the offshore heavy lift DP2 jack-up vessel Innovation from the DEME group is studied. Firstly, two dimensional numerical tests of a cross section of the hull are performed using different mesh motion techniques: mesh morphing and the overset method. Subsequently, a full three dimensional simulation is performed for a roll decay test and validated by using experimental data measured in the MARIN seakeeping and manoeuvring basin. Lastly, the vessel is freely floating and responding to an incoming regular wave field. Therefore, we extend the algorithm for fluid-motion coupling as developed in [2] to multiple degrees of freedom and the numerical results are verified and validated using experimental measurements.

REFERENCES

[1] OpenCFD. OpenFOAM 2018. https://www.openfoam.com/.

[2] Devolder B, Troch P, Rauwoens P. Accelerated numerical simulations of a heaving floating body by coupling a motion solver with a two-phase fluid solver. Comput Math with Appl 2018. doi:10.1016/j.camwa.2018.08.064.