ACFD model for the LIFES50+ OO-Star Wind Floater Semi 10MW

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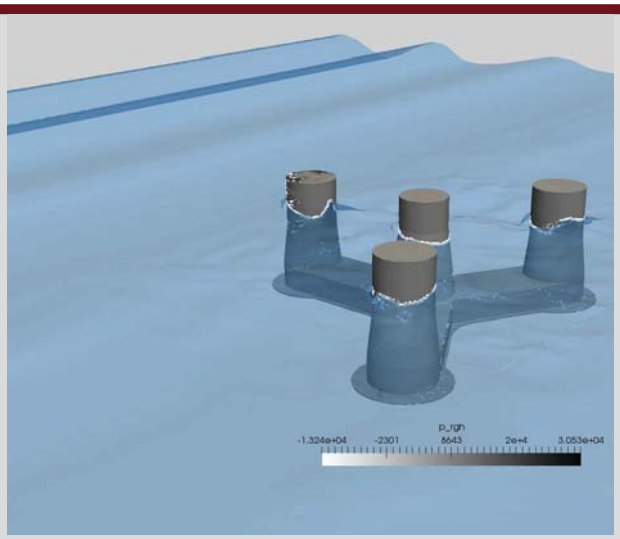
Introduction

Development of offshore wind farms at intermediate depths rely on the efficient design of floating platforms. While their motion response in wind and waves is often well predicted by the established aero-hydro-elastic models, the forcing from nonlinear waves, viscous damping effects and green-water events require higher fidelity modelling such as fully coupled computational fluid dynamics (CFD) simulations. In this paper, we present the numerical setup and validation of a two-phase CFD solver for the LIFES50+ OO-Star Wind Floater Semi 10 MW, hereafter called OO-Star floater for brevity. The floater has been selected by the LIFES50+ [1] project for extended numerical modelling and physical model tests.

Numerical set up

The open source toolbox, OpenFOAM [2] is employed and a moving mesh technique is used to account for floating body motions in waves. The grid is generated and refined by importing the geometry and using the unstructured meshing library, snappyHexMesh. For this presentation, first order Stokes waves are generated with the waves2Foam wave generation toolbox [3] and by use of a relaxation zone approach on the far-field. Figure 1 shows a snapshot of the numerical domain and the floater and the corresponding dimensions. .

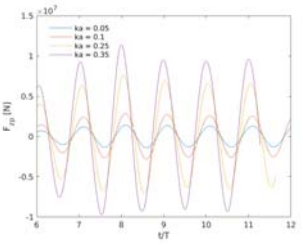


Type	Material	Draft	Freeboard	Displaced volume	Platform mass
		[m]	[m]	[m³]	[kg]
Semisubmersible	Post-tensioned concrete	22.00	11.0	2.3509E+04	2.1709E+07

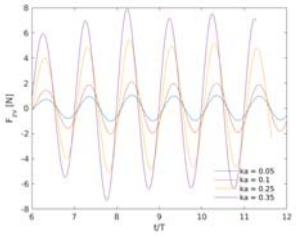
Figure 1. A snapshot of the floater subject to linear waves in CFD domain (up), main characteristics of the floater (down)

Results – Wave excitation forces on the fixed floater

Three incident waves of steepness ratios from 0.05 to 0.35 are simulated:



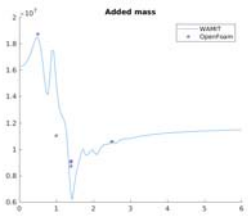
Pressure forces



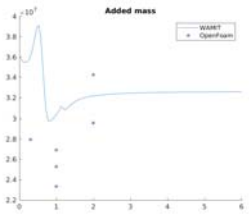
Viscous forces

Results – Floater's hydrodynamic coefficients

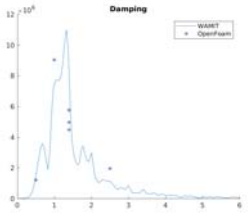
Response of the floater to forced surge and heave motions in calm water are analysed to obtain added mass and damping coefficients:



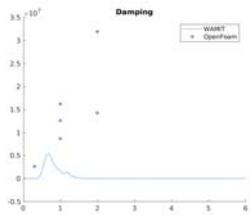
Added mass in surge



Addedmass in heave



Damping in surge



Damping in heave

* CFD _____ Fast computations [1]

References

[1] Pegalajar-Jurado, A; Borg, M.; Bredmose, H., Qualification of innovative floating substructures for 10MW wind turbines and water depths greater than 50m, LIFES50+ Deliverable, project 640741.

[2] H. G. Weller, G. Tabor, H. Jasak, C. Fureby, A tensorial approach to computational continuum mechanics using object-oriented techniques, COMPUTERS IN PHYSICS, VOL. 12, NO. 6, NOV/DEC 1998

[3] Jacobsen, N.G., Fuhrman, D.R. and Fredsøe, J., 2012. A wave generation toolbox for the open-source CFD library: OpenFoam®. International Journal for Numerical Methods in Fluids, 70(9), pp.1073-1088.

Acknowledgments

This work is part of the project LIFES50+. The research leading to these results has received funding from the European Union Horizon2020 programme under the agreement H2020-LCE-2014-1-640741.

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