Comparison of the Lifting Line Free Vortex Wake method and the Blade Element Momentum method for the unsteady aerodynamics of a 15MW FOWT

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Background

Ongoing research is dedicated to Floating Offshore Wind Turbines (FOWT's), with a significant emphasis on studying rotor aerodynamics. The combined floating platform motions of a FOWT, especially when considering six degrees of freedom, lead to more complicated angle of attack fluctuations compared to fixed wind turbines.[1]

In order to model the complex aerodynamics of a FOWT several simulation tools can be of use. These range from the simpler Blade Element Momentum (BEM) method to the more resource-demanding Computational Fluid Dynamics (CFD) models. Vorticity-based methods occupy a middle ground in terms of complexity, computational expenses and the physics-based representation. They offer increased reliability compared to BEM models while demanding lower computational resources than comprehensive CFD models.[2]

Objective

The constraints inherent in the assumptions upon which BEM is founded limit its applicability in specific scenarios. The goal is to investigate for which met-ocean conditions using a vorticity-based method would be beneficial to using BEM. This is done by simulating the unsteady operation of a 15MW FOWT with the Lifting Line Free Vortex Wake model from QBlade and comparing the results to data obtained with BEM through OpenFAST. This will provide more insight in when to employ either of the methods and the distinctions between them. The reference turbine is the IEA 15MW VolturnUS-S turbine + floater.[3]

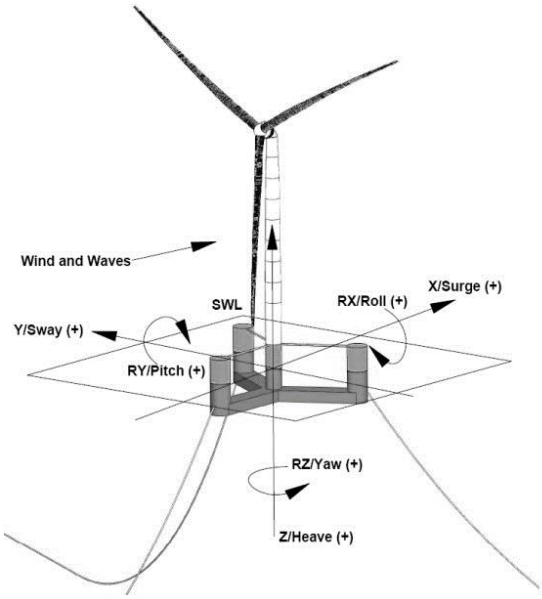

***Figure 1**. The reference turbine.*

[1] D. Micallef and A. Rezaeiha, *Floating offshore wind turbine aerodynamics: Trends and future challenges*. In: Renewable and Sustainable Energy Reviews 152, 2021.
[2] J. G. Schepers, *Engineering models in wind energy aerodynamics: Development, implementation and analysis using dedicated aerodynamic measurements*. PhD thesis. TU Delft, 2012.
[3] C. Allen, A. Viselli, et al. *Definition of the UMaine VolturnUS-S Reference Platform Developed for the IEA Wind 15-Megawatt Offshore Reference Wind Turbine*. Tech. rep. NREL, 2020.