

Methodology for determination of vibration damping of an offshore wind turbine supporting structure

PhD student: Jonas Gad Kjeld
University supervisors: Anders Brandt, Vikas Arora
Company supervisors: Jacob Karottki Falk Andersen, Bo Terp Paulsen, Christian Pavese
Period: 01-10-2018 – 30-09-2021
E-mail: jonas.kjeld@vattenfall.com

Industrial PhD

In collaboration with
Vattenfall Vindkraft A/S
&
University of Southern Denmark,
Department of Technology and
Innovation

Jonas Gad Kjeld
MSc in Structural Engineering



Background

One of the major costs of an offshore wind farm is related to the foundations that support wind turbine generators (WTG). Fatigue loads govern the structural dimensions of the foundation, in most cases, due to its dynamic nature and exposure of dynamic forces and this has a direct impact on the cost of the foundation itself.

Current design procedure of WTG foundations involves highly dynamic and sophisticated integrated simulations of the whole system exposed to both environmental loads, including wind and wave loads, as well as the active control system of the WTG itself. Due to the complexity of the system, and existing knowledge gaps, a number of assumptions and simplifications are present in the design.

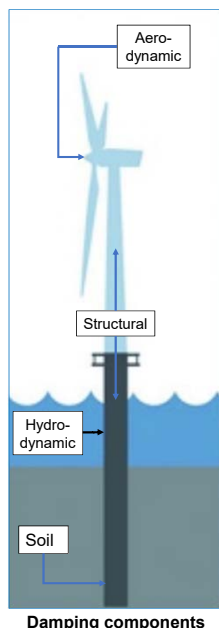
Some of these assumptions and simplifications are related to the total damping of the system which is a decisive parameter in determination of e.g. the level of fatigue loads present in the structure.

Objectives

The overall objective of this industrial PhD project is to develop a methodology for measurement and assessment of the dynamic parameters of a WTG structure including foundation with focus on total damping and its different components, i.e. aerodynamic, structural, hydrodynamic and soil damping. This methodology will be based on advanced dynamical analysis of measurements conducted on existing support structures in operation.

Secondly, comparison of design assumptions regarding dynamic properties, including damping and natural frequencies, with measured values and assessment of degree of conservatism built-in in an original design will be carried out.

Finally, verification of available damping assessment models and guidance on application in simulations will be performed.



Damping components

Contribution

The project outcome shall be a reliable method for determination of a total value of damping, and its segregation into particular components, on a target substructure to a practical degree of accuracy. Additionally, the project shall deliver a low cost standard solution for a measurement system and damping assessment methodology.

This industrial PhD project will also help bridge the gap between scientific knowledge on damping quantification and current industry practice.

A basis for development and improvement to current design procedures as regards the dynamical behavior of the structure will be created. It is expected that this will reduce the cost of new supporting structures and predict more precise lifetime extension of existing structures.

Company

Vattenfall is one of the leading actors in developing, constructing, and operating large-scale offshore wind farms, with the purpose of generating green electricity, for their core markets in northern Europe.

Vattenfall is an especially strong player on the Danish energy market. Here, Vattenfall is constructing over 1300 MW offshore wind towards 2021, which will make Vattenfall, by far, the biggest operator of wind farms, both on and offshore, in Denmark.

Vattenfall has a clear ambition to reduce the price of green energy from offshore wind and to compete with other energy sources in a subsidy free energy market. In order to fulfil this ambition, Vattenfall must pursue every possibility to reduce the cost throughout the life cycle of a wind farm, from initial development thoughts to final decommissioning.

An overview over Vattenfall's offshore windfarms and some key figures are given below.

