Internship assignment @ Siemens Wind Power

"The DISSTINCT shaker experiment; identification of an installed monopile"

Duration:	3 months
Starting date:	October 2015
Supervisors Siemens:	Jeroen Bongers / Paul van der Valk
Field of research:	Wind turbine engineering
Keywords:	Structural dynamics, offshore wind turbines, experimental dynamics, soil-structure interaction

Introduction

At present there are few topics as heavily debated as "sustainability"'. On a daily basis the media are full of items on climate change, oil prices, CO2 reductions, rising energy consumption and so on. Regardless of one's opinion on the subject, a fact of the matter is that more sustainable ways of power generation need to be found simply because the currently used resources will someday be exhausted.

One of the more promising ways of generating "green"' electricity on a large scale is provided by wind energy. As a result, the wind turbine industry has undergone a huge transition: from a small group of (mainly Danish) enthusiasts in the early 1980's to a competitive, globalized multibillion dollar industry. However, to enable wind power to truly fulfill a significant role in a sustainable future energy supply, continuous technological innovation is needed in order to achieve the required cost reduction.

As the interaction of the soil with the monopile is a mechanism that is important for the dynamic behavior of an offshore wind turbine, the DISSTINCT (Dynamic Soil-Structure Interaction) project was started. This project aims at providing better insight into, and better models describing, these phenomena. An important step in this project has been the full-scale shaker experiments that have been performed on two monopiles in the Westermeerwind near-shore wind farm in the Netherlands.

General Problem Description

The full-scale shaker measurements mentioned earlier have been performed in the beginning of July 2015. The goal of this internship assignment would be to process the obtained measurement data, in order to extract the global structural properties of the soil-pile system.

This is an important first step into updating the current industry standard modeling approaches, which are believed to be too conservative. As this high conservatism leads to more material being used for the supporting structure of a wind turbine, it directly influences the levelized cost of energy (LCOE) of offshore wind generated electricity. Hence, it is believed that the measurements performed can be used to lower the LCOE on a relatively short term.

Assignment

The goal of the assignment can be summarized as follows:

"Extract the global structural properties of an installed monopile from the available measurement data and estimate the effective stiffness and damping of its surrounding soil."

From this goal a number of different tasks can be identified, such as:

- Characterize the behavior of the monopile shaker in order to better predict the unbalance forces generated. As the rotational speed of the large unbalance shaker showed fluctuations around the

target rotational speed, it is important to characterize the frequency effects of this on the produced force.
- Estimate the eigenfrequency, damping ratio and mode shape related to the first natural frequency of the installed monopile.
- Determine the modal mass and modal stiffness related to the first mode and compare these to their counterparts from the industry standard model, in order to quantify the conservatism in the current modeling approach.

Requirements
In order to successfully tackle this internship project, the candidates should:

- Have profound knowledge of structural dynamics;
- Have some experience in the field of experimental dynamics;
- Have solid experience with programming in Matlab;
- Have affinity with the wind turbine industry;
- Have the capability of enhancing and implementing specific knowledge extracted from scientific publications;
- Possess good communication skills, both verbal and written.