

2012/13 Undergraduate Research Grant Scheme

Project title: Model testing for the optimum arrangement for multi-pod foundation supported wind turbines

University: University of Bristol

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Aims of research:

It has been acknowledged that offshore wind turbines can produce reliable quantities of renewable energy and dynamic soil-structure interaction along with foundation design is a challenge. In most of Round 1 and Round 2 developments in UK waters, monopile type of foundation has been used where water depth is about 30m. Monopile is no longer feasible in water depths more than 30m due to lack of installation vessels for the large size monopile required (>7m diameter) and the transition piece limitations. As a result, multiple pod foundation is currently being considered.

This research aims to determine the effect of different arrangements of multi-pod foundations have on the natural frequency of offshore wind turbines. There are many options when deciding to support an offshore wind turbine, including asymmetric and symmetric layouts. This research is important as preventing resonance occurring at operational frequencies is vital to the lifespan of a wind turbine structure. The natural frequencies of a wind turbine system are carefully designed to sit between the main operational frequencies experienced so as to avoid resonance. Thus, any variation in natural frequency between layouts must be identified in order to avoid the system tending towards resonance.

Description of method:

Arrangements of multiple pod foundations in a form either symmetric or asymmetric has been proposed in the literature yet there are still remaining issues regarding their long-term performance. Recent research conducted at the University of Bristol focused on a prototype asymmetric caisson foundation layout (tripod) and found a particular limitation in the sense that there are two close low order natural modes of the system. These modes arise from the rocking of the foundation about their principle axes. It is necessary to space out these peaks from the forcing, otherwise this effect can potentially increase the stress levels of the foundation supports and lead to premature fatigue damages.

The aims of the research are:

1. To identify a relationship between mass distribution along the turbine tower and the natural frequencies of the multi-caisson system through the development of non-dimensional groups.
3. Design, built and test small scale foundation system. Firstly a range of multipod arrangements need to be identified. The test would include building a test bed of sand and clay, designing and building small scale models. Actuators will be used to apply repeated loads and accelerometers will be used to get the response.

Benefits to structural engineering:

Large scale offshore wind turbines are being constructed around Europe. Multipod foundations (i.e. jacket or tripod) are considered as an option. Design of such system involved analysis of complex dynamic fluid-structure-soil interaction. Analysing these model tests can develop an understanding on some aspects of the dynamics and shed some lights on the feasibility of such systems.

Proposed finish date: May 13