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PhD Thesis: Long term effects of soil – structure degradations of wind turbine foundations on deep water: Department of Civil Engineering, Aalborg University, Unpublished

Abstract: The aim of the PhD project is to analyse a part of the design method used for the piles in the foundation for a jacket construction for offshore wind turbines. For a jacket construction, the foundation consists of three or four long piles driven into the seabed. The wind turbines are subjected to loads from wind and waves. The loads are transferred to the underlying soil through the following: Lateral contact pressure between soil and pile, friction along the pile, and contact pressure between soil and pile tip. The last two are referred to as the axial capacity of the pile. This PhD project deals with the design methods for this axial capacity.

Even though the wind turbine is subjected to cyclic loading, piles are currently designed by methods based on static, monotonic loading. Thus, when the foundation is designed, the loads from wind and waves are interpreted as a quasi-static loads used in the design formulations. The formulations given in the design regulations have been shown to give incorrect predictions of the axial bearing capacities of piles. Therefore, several new design methods have been developed.

However, none of the new design methods takes cyclic loading and the resulting long term effects into account. One of the recently observed problems concerning cyclic loading is a 'shake-up' effect of the foundation. Because of the low weight of the wind turbine, the loads induced by the waves cause tension in the piles, and exposed to the wave loads for a long period of time the piles experience a 'shake-up' effect.

To analyse the effect of the cyclic loading, laboratory tests on axially loaded piles are conducted. Analyses of the results from these tests should result in a method to take account of the long term effects in the design. The design method should be able to predict the deformation of the foundation after a lifetime of 20 years. The new design method should be implemented in a computational program.

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