Offshore & Dredging Engineering

Technische Universiteit Delft

Workability assessment of a monopile installation system with a dynamically positioned vessel

Renewable energy is evolving to a source of increasing importance for the global energy supply. Within the renewables market, the offshore wind sector has become an important participant and experienced a rapid growth during the last years. Over 80% of the support structures of offshore wind turbines are monopiles (large diameter steel cylinders). These monopiles are installed by either dedicated jack-ups or floating vessels. Due to the trend of offshore wind farms to deeper waters and the installation of larger monopiles, the more cost effective option may become the floating vessels for all installation cases in the future.

The Oleg Strashnov, a heavy lift vessel that is owned by Seaway Heavy Lifting (SHL), is used for the installation of monopiles. Currently, the company executes this operation with a moored floating vessel. Since running and picking up of the anchors consumes over 40% of the total duration of a monopile installation, SHL desires station keeping with a dynamically positioned (DP) vessel. A workability assessment is performed for monopile installation with a DP vessel, where the modelling of the monopile installation system is analysed and a comparison is made between the moored and DP cases.

In the industry, the conventional method to analyse the workability of a DP vessel is by means of static DP capability plots, which include limited dynamic effects. The vessel is fixed, and constant wind, mean wave drift and current loadings are incorporated. However, the major drawback of this method is that it does not consider the dynamic effects properly and could lead to unrealistic allowable environmental conditions.

For this reason, two dynamic models are developed in this study in order to compare the moored and DP monopile installation systems. In these models, the vessel and monopile are connected by means of the active controlled motion compensated outrigger. To investigate the most critical phase of the monopile installation sequence, the monopile is lowered until self-weight penetration and the hammer is placed on top (see Figure 1). Considering various nonlinearities in the installation system, such as control systems and viscous drag forces, the Cummins equation provides a satisfactory approach in the time domain. However, the convolution integral is inconvenient for computational analysis and is therefore approximated by a state-space subsystem with the MSS Toolbox. A verification study is performed by a comparison of the dynamic vessel model provided with the state-space approximation and an AQWA simulation including the convolution integral. The dynamic installation models are subjected to collinear environmental conditions, determined with potential theory and viscous drag calculations. During one hour simulations, limiting values of the wind, wave and current loads are determined below which the operation can still be executed. From these results, dynamic capability plots are constructed.

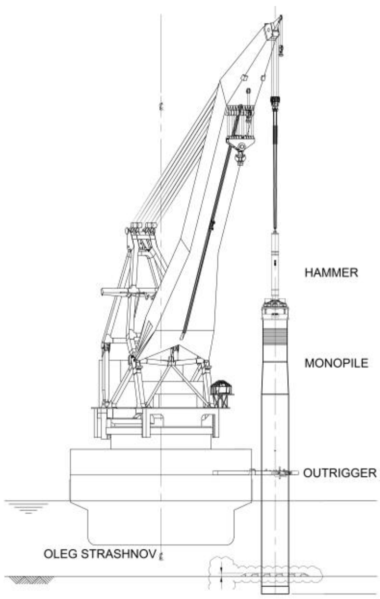

Figure 1: Monopile installation system

The limiting environmental conditions are closely related for the moored and DP monopile installation methods. However, the DP installation system proves to be superior since it can optimize the heading during an installation, which is not the case for the moored vessel. In conclusion, a time reduction could be realized by the installation of monopiles with a dynamically positioned vessel. In this study, an ideal DP system is considered. Implementing a DP system that is closer related to the real system may have a significant impact on the results of the simulations. In addition, the systems prove to be highly sensitive for variations in the hydrodynamic coefficients. Thorough investigation is therefore needed for the determination of realistic viscous drag loads in future studies.

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