Technische Universiteit Delft

Offshore & Dredging Engineering

Integral soil-jack-up modelling


Figure 1: Wind turbine installation vessel

Due to the growing offshore wind energy market and the increasing interest of the oil and gas industry, there is a steadily increasing demand for the use of jack-ups all over the world. Particularly, the number of wind turbine installation vessels has increased from 2 in 2005 to 40 currently, with a yearly growth expectation of 30% till 2020.

Accident statistics from the Worldwide Offshore Accident Databank show the necessity for safer designs of jack-ups and other mobile offshore platforms. A better understanding of the soil-structure interaction and an accurate estimation of the limiting loading conditions can contribute to the reduction of this failure rate.

To comprehensively study the jack-up response, an integral parametric model is developed. This jack-up model combines a force resultant soil-spudcan interaction model with a structural model of the jack-up, both with 6 degrees of freedom (DOF). Environmental loads are applied to the structural model to estimate load distribution among the spudcans and in the jack-up structure.

Inputs for the jack-up model are structural properties, soil-foundation interaction parameters, environmental conditions and preload forces. As output, the integral jack-up model provides hull and spudcan displacements for 6 DOF, internal forces and internal moments at the leg-hull connection and forces and moments applied on the soil. Furthermore, the model checks if the spudcan loads, applied to the soil, stay within the yield surface, which means that the soil response is linear elastic and the elastic soil model is valid.

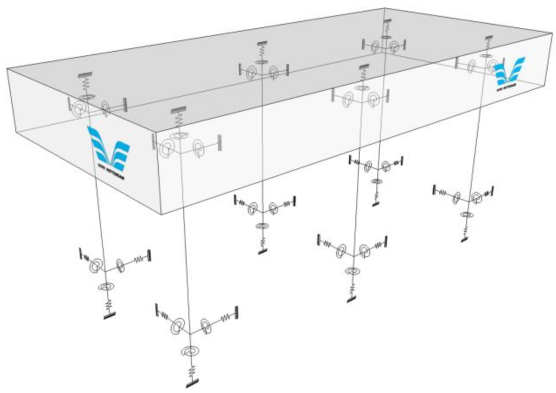
Figure 2: Soil-Jack-up model

The results of the jack-up model are validated against data from push-over tests to assess the response of the jack-up model, and within the range of a substantially linear soil-spudcan interaction. The environmental loads are also validated against available data from Vuyk.

To assess the value of the chosen soil-spudcan interaction model, a comparison is made with two other widely used soil-spudcan interaction models: a pinned soil-spudcan connection and a rotational spring connection. The comparison showed that the implemented soil-spudcan interaction model provide highly accurate results, in contradiction to the pinned and rotational spring connection. The rotational stiffness included in the soil-spudcan interaction model reduces the bending moment in the jack-up legs significantly. Use of the pinned soil-spudcan interaction model overestimates the bending moment in the leg. The rotational spring however, underestimates the leg bending moment.

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