

**Seismic analysis of cranes on jack-ups**

GustoMSC, an NOV company, is a market leader in the design of offshore wind installation jackups. Offshore wind turbine installation has been situated mainly in the North Sea, which is not very seismically active. As a consequence, wind turbine installation jackups have been designed and analysed for low seismic excitations. The offshore wind industry is expanding to East Asia, where it finds itself in seismically active regions where seismic excitations are significantly higher. Therefore, operators are requesting GustoMSC to supply input for risk analyses of their jackups and its crane. GustoMSC requires a tool to conduct ultimate limit state analyses of a jackup and its crane under seismic conditions. This tool has been created and applied in this work.

The main challenge of this thesis is related to the estimation of the probability of exceedance of a predefined structural limit of a crane on a jackup given a set of seismic ground motions. To tackle this challenge, suitable models of the jackup and crane substructure are developed and verified. With use of a data package, containing two months worth of wind turbine installation data, a Monte Carlo analysis is conducted to determine the probability of exceedance of the structural limit in a 50-year period. When constructing the jackup model, the mass and stiffness distribution of the jackup is important for an accurate response, a slight eccentricity in the mass of the jackup leads to a very different response. A tool has been created which ensures the mass distribution and eccentricity are incorporated to the degree of accuracy required.

To determine the probability of exceedance of the structural limit in a 50-year period, the seismic analysis tool has been used to conduct a Monte Carlo analysis. Using data from a previous wind park installation operation and ISO 1990XX standards and Eurocode 8, probability distributions have been created for the boom angle, slewing angle, hook load, earthquake timetrace, angle of incidence of excitation and probability of occurrence of the earthquake. By including all relevant variables, the work in this thesis has determined the probability of exceedance of the structural limit for a 50-year period to be 7.7%.

The tools and method created in this thesis allows for the probability of exceedance of the structural limit due to seismic excitation to be determined. Creation of this tool allows GustoMSC to consider high seismic excitations in future designs.

---

Student

Joost Linthorst  
July 26th, 2019

Sponsor

GUSTOMSc

Thesis committee

Prof.dr. A. Metrikine  
Dr. A. Tsouvalas  
Dr.ir. K.N. van Dalen  
Ir. P. van Uchelen  
Ir. R. van der Meulen