A probabilistic analysis of the dynamic response of monopile foundations: Soil variability and its consequences - DTU Orbit (14/10/2019)

A probabilistic analysis of the dynamic response of monopile foundations: Soil variability and its consequences

The reliability of offshore wind turbines is highly influenced by the uncertainties related to the subsoil conditions. Traditionally, the evaluation of the dynamic structural behaviour is based on a computational model with deterministic soil properties. Using this approach, however, provides limited insight into the variation of the estimate of the inherent modal properties and loads. In this paper, a comprehensive study is performed on the dynamic behaviour of an offshore wind turbine installed on a monopile foundation. Based on consistent lumped-parameter models calibrated to semi-analytical impedance functions of a monopile embedded in a stochastic linear viscoelastic soil layer, fully coupled aero-hydro-elastic simulations are conducted in the nonlinear multi-body code Hawc2. The probabilistic analysis accounts for the uncertainty of soil properties (e.g. damping and stiffness) and relies on a Monte Carlo method facilitating the derivation of the probability densities of the modal properties and the fatigue loading. The main conclusion of the presented work is that the dynamic structural behaviour of the wind turbine and its support structure is strongly affected by the stochastic soil properties. Lognormal and Gumbel distributed modal damping and accumulated side-side fatigue damage equivalent moments with a coefficient of variation of 30% and 8%, respectively, are observed.

General information
Publication status: Published
Organisations: Department of Wind Energy, Vestas Wind Systems AS, Aalborg University
Contributors: Damgaard, M., Andersen, L., Ibsen, L., Toft, H., Sørensen, J. D.
Number of pages: 14
Pages: 46-59
Publication date: 2015
Peer-reviewed: Yes

Publication information
Journal: Probabilistic Engineering Mechanics
Volume: 41
ISSN (Print): 0266-8920
Ratings:
BFI (2015): BFI-level 2
Scopus rating (2015): CiteScore 2.1 SJR 1.137 SNIP 1.922
Web of Science (2015): Impact factor 1.241
Web of Science (2015): Indexed yes
Original language: English
Keywords: Fatigue, Lumped-parameter model, Soil dynamics, Soil variability, Wind turbine, Damping, Dynamic response, Fatigue damage, Fatigue of materials, Monte Carlo methods, Soil mechanics, Soils, Stochastic models, Stochastic systems, Uncertainty analysis, Wind turbines, Impedance functions, Lumped parameter modeling, Lumped parameter models, Probabilistic analysis, Probability densities, Soil variabilities, Structural behaviour, Offshore wind turbines
DOIs: 10.1016/j.probengmech.2015.05.001
Source: FindIt
Source ID: 275043782
Research output: Contribution to journal › Journal article – Annual report year: 2015 › Research › peer-review