

# Abstract

This thesis addresses monitoring and operational modal analysis of a full-scale offshore wind turbine located at the DanTysk wind farm. The aim of this work is to experimentally determine the vibration damping of an offshore wind turbine and its supporting structure. In the early stages of the PhD project, a measurement system was designed and installed with the purpose of monitoring the tower accelerations of the dedicated offshore wind turbine. A finite element model of the dedicated offshore wind turbine was established with the purpose of obtaining the modal properties of the structure which was then used to create a basis for selecting sensor locations for the monitoring campaign as well as creating simulated time responses for analytical analyses.

Due to large volumes of acceleration measurements collected from nearly two years of continuous monitoring, an Automated Operational Modal Analysis was implemented to track and match modal parameters obtained from different analysis periods. Modal parameters of an offshore wind turbine are influenced by notable uncertainties derived from the variability of environmental and operational conditions and the system identification itself, even during idle or parked conditions. These uncertainties were reduced by segregating environmental and operational parameters in confined intervals, and by investigating the adjustment parameters of the modal parameter estimation method applied in the automated analysis. Moreover, the main contributing factors of the total damping were addressed by considering environmental effects such as the wind speed and the wave height during idle operation. A significant correlation was found between modal parameters and these environmental effects and based on this, the least possible damping within a 90 % confidence interval was extrapolated from a scenario without any ambient excitation on the structure. The median of the total damping did show a potential of increasing the actual damping applied in the design of the dedicated wind turbine whereas the estimated 5 % fractile did comply very well with the design values of the damping.