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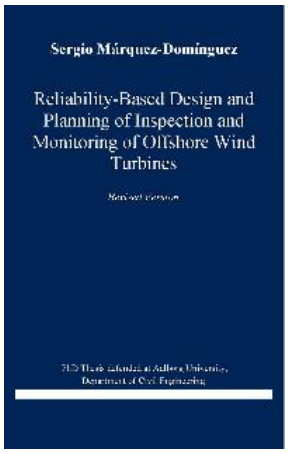

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Reliability-Based Design and Planning of Inspection and Monitoring of Off Shore Wind Turbines

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e-ISBN: 9788793102620
Available From: January 2014
Price: € 0.00

Description:

Maintaining and developing a sustainable wind industry is the main motivation of this PhD thesis entitled "Reliability-based design and planning of inspection and monitoring of offshore wind turbines". In this thesis, statistical methods and probability theory are important mathematical tools used to estimate the load characteristics which affect the strength of wind turbine substructures. Reliability methods (FORM/SORM) are applied to determine the probability of failure of both onshore and offshore wind turbines. So, technical and economic strategies are presented in order to find an optimum balance between the costs of the substructures and the annual wind energy production as well as to maximize the benefits coming from adequate operational control configurations which will increase the material saving in the substructures. The key goal is to decrease the cost of energy (CoE) considering, at the same time, a suitable life-cycle for the offshore wind turbines, assuring an acceptable risk level.

The probabilistic tools relate to and use the expertise developed in the oil and gas industry. The expertise can be applied to the wind industry in order to optimize the structural design with respect to the fatigue damage. Improvement could be made possible by using design and limit state equations (LSEs) to be applied to steel and reinforced concrete OWT substructures for both new and existing wind turbines. These design and LSEs can be established by taking into account an intricate load interaction produced by the natural phenomena, i.e. wind and waves. This load interaction has an important influence on the dynamical behaviour as well as on the fatigue damage of the wind turbine structure, influencing its reliability and stability.

In summation, wind, currents and sea loads can be considered as stochastic processes which will produce fatigue damages in the offshore wind turbines substructures. Steel and reinforced concrete components can contain cracks and fractures due to fatigue. This project concentrates on the development of methodologies to be applied for steel and reinforced concrete onshore and offshore wind turbine foundations with the aim of improving the design, decreasing structural costs and increasing benefits.

Recently, wind energy technology has started to adopt risk and reliability based inspection planning (RBI) as a methodology based on Bayesian decision theories together with structural reliability analysis to identify suitable strategies in order to inspect and control the deterioration problems in offshore wind turbines substructures.

Keywords: Offshore Wind Turbines, Sustainable Design, Reliability, Inspection, Probability, Failure, Costs