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Reducing Uncertainty of Monte Carlo Estimated Fatigue Damage in Offshore Wind Turbines Using FORM

Authors : Jan-Tore H. Horn, Jørgen Juncher Jensen

Abstract : Uncertainties related to fatigue damage estimation of non-linear systems are highly dependent on the tail behaviour and extreme values of the stress range distribution. By using a combination of the First Order Reliability Method (FORM) and Monte Carlo simulations (MCS), the accuracy of the fatigue estimations may be improved for the same computational efforts. The method is applied to a bottom-fixed, monopile-supported large offshore wind turbine, which is a non-linear and dynamically sensitive system. Different curve fitting techniques to the fatigue damage distribution have been used depending on the sea-state dependent response characteristics, and the effect of a bi-linear S-N curve is discussed. Finally, analyses are performed on several environmental conditions to investigate the long-term applicability of this multistep method. Wave loads are calculated using state-of-the-art theory, while wind loads are applied with a simplified model based on rotor thrust coefficients.

Keywords : fatigue damage, FORM, monopile, Monte Carlo, simulation, wind turbine
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