11th World Congress on Structural and Multidisciplinary Optimisation
07th -12th, June 2015, Sydney Australia

Structural Dynamic Topology Optimisation of a Direct-Drive Single Bearing Wind Turbine Generator

M. Kirschneck[1], H. Polinder[1], R.A.J. van Ostayen[1], F.C.M. van Kempen[1], D.J. Rixen[2]

[1] Delft University of Technology, Delft, The Netherlands, m.kirschneck@tudelft.nl;
[2] Technische Universitat Munchen, Munich, Germany;

Abstract

Reducing weight of off-shore wind turbine nacelles is currently a key driver of innovation within the wind turbine industry. Weight reduction will not only lead to smaller loads and thus smaller towers of the turbine, but also reduce logistic costs during the turbine's installation. This holds even more so for off-shore turbines, the costs related to installing a turbine is a substantial investment compared to the operational cost. A reduced nacelle weight will, subsequently, lead to reduced cost of wind energy.

For direct-drive turbines, the generator is one of the heaviest parts of the wind turbine nacelle. Due to the low rotational speed of the generator, the loads are especially high in this type of turbine, which increases the necessary structural mass of the rotor. Recently, designed flexibility has been identified as one approach to achieve weight reduction. However, reducing the weight of the support structure has proven difficult, due to the complex pattern of dynamic excitation forces.

Until now, density based topology optimisation has hardly been employed for the design of wind turbine parts. This publication investigates the possible weight reduction which results from applying this method to the support structure of the generator rotor. As a first step, crucial excitation frequencies and spatial force distributions that are generated by the magnetic field are presented. Then the topology optimisation is executed using a modal and a harmonic approach, applying the identified force distributions.

Keywords: density based structural topology optimisation; direct-drive wind turbine generators; modal participation factors.