Assessment of wind turbine drive-train fatigue loads under torsional excitation

This paper establishes validated models that can accurately account for the dynamics of the gearbox, along with the external dynamics that excite the system. A drive-train model implementation is presented where the gearbox and generator are coupled to the wind turbine structure in a dynamic simulation environment. The wind turbine is modelled using HAWC2 (Horizontal Axis Wind turbine simulation Code 2nd generation) and the gearbox is described using lumped parameters in MATLAB/Simulink. Each component in the gearbox model includes rotational and translational degree-of-freedom (DOF), which allows the computation of the bearing and gear-mesh loads. The proposed models are validated by experiments from a 750 kW test-rig. The drive-train model is configured for a 5 MW power capacity and coupled to the corresponding wind turbine and load simulations are carried out under turbulent wind following the guidelines from the IEC 61400-1 standard. Fatigue analysis shows the effect in the bearing damage equivalent loads, when including a detailed drive-train model in the overall wind turbine simulation for a 20 year period. Results show a higher level of damage (up to 180%) when the detailed model is used in comparison to a simplified approach for load calculation. It is found that some of the wind turbine modes can have negative consequences on the life-time of the planetary bearings. © 2015 Elsevier Ltd. All rights reserved.

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