Combined Structural Optimization and Aeroelastic Analysis of a Vertical Axis Wind Turbine - DTU Orbit (08/11/2017)

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Floating offshore wind energy poses challenges on the turbine design. A possible solution is vertical axis wind turbines, which are possibly easier to scale-up and require less components (lower maintenance) and a smaller floating structure than horizontal axis wind turbines. This paper presents a structural optimization and aeroelastic analysis of an optimized Troposkein vertical axis wind turbine to minimize the relation between the rotor mass and the swept area. The aeroelastic behavior of the different designs has been analyzed using a modified version of the HAWC2 code with the Actuator Cylinder model to compute the aerodynamics of the vertical axis wind turbine. The combined shape and topology optimization of a vertical axis wind turbine show a minimum mass to area ratio of 1.82 kg/m² for blades with varying blade sections from a NACA 0040 at the attachment points to a NACA 0015 in the equatorial region. During an aeroelastic analysis of the wind turbine a maximum flapwise deflection of 0.45 m and a maximum edgewise deflection of 0.47 m were found. While the turbine is aeroelastically stable, an oscillation as a result of resonance reduces the fatigue life.

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