Load Consequences when Sweeping Blades - A Case Study of a 5 MW Pitch Controlled Wind Turbine - DTU Orbit (08/12/2018)

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The generic 5 MW NREL wind turbine model is used in Risø’s aeroelastic simulator HAWC2 to investigate 120 different swept blade configurations (forward and backward sweep). Sensitivity for 2 different controllers is considered as well. Backward sweep results in a pitch to feather torsional moment of the blade, effectively reducing blade twist angles under increased loading. This behaviour results in decreased flap-wise fatigue and extreme loads, an increase for edge-wise fatigue loading and status quo or slight decrease in extreme loads (depending on the controller). Tower base and shaft-end bending moments are reduced as well. Forward sweep leads to an increase in angle of attack under loading. For a pitch controlled turbine this leads to an increase in fatigue and extreme loading in all cases. An controller inflicted instability is present for the more extreme forward swept cases. Due to the shape of considered sweep curves, an inherent and significant increase in torsional blade root bending moment is noted. A boomerang shaped sweep curve is proposed to counteract this problematic increased loading. Controller sensitivity shows that adding sweep affects some loadings differently. Power output is reduced for backward sweep since the blade twist is optimized as a rigid structure, ignoring the torsional deformations which for a swept blade can be significant.

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