Effects of extreme wind shear on aeroelastic modal damping of wind turbines - DTU Orbit (24/12/2018)

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Wind shear is an important contributor to fatigue loads on wind turbines. Because it causes an azimuthal variation in angle of attack, it can also affect aerodynamic damping. In this paper, a linearized model of a wind turbine, based on the nonlinear aeroelastic code BHawC, is used to investigate the effect of wind shear on the modal damping of the turbine. In isotropic conditions with a uniform wind field, the modal properties can be extracted from the system matrix transformed into the inertial frame using the Coleman transformation. In shear conditions, an implicit Floquet analysis, which reduces the computational burden associated with classical Floquet analysis, is used for modal analysis. The methods are applied to a 2.3 MW three-bladed pitch-regulated wind turbine showing a difference in damping between isotropic and extreme shear conditions at rated wind speed when the turbine is operating closest to stall. The first longitudinal tower mode decreases slightly in damping, whereas the first flapwise backward whirling and symmetric modes increase in damping. This change in damping is attributed to an interaction between the periodic blade mode shapes and the azimuth-dependent local aerodynamic damping in the shear condition caused by a beginning separation of the flow. Copyright © 2012 John Wiley & Sons, Ltd.