Modal Properties and Stability of Bend-Twist Coupled Wind Turbine Blades - DTU Orbit (16/12/2018)

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Coupling between bending and twist has a significant influence on the aeroelastic response of wind turbine blades. The coupling can arise from the blade geometry (e.g. sweep, prebending or deflection under load) or from the anisotropic properties of the blade material. Bend-twist coupling can be utilised to reduce the fatigue loads of wind turbine blades. In this study the effect of material based coupling on the aeroelastic modal properties and stability limits of the DTU 10 MW Reference Wind Turbine are investigated. The modal properties are determined by means of eigenvalue analysis around a steady-state equilibrium using the aero-servo-elastic tool HAWCStab2 which has been extended by a beam element that allows for fully coupled cross-sectional properties. Bend-twist coupling is introduced in the cross-sectional stiffness matrix by means of coupling coefficients that introduce twist for flapwise (flap-twist coupling) or edgewise (edge-twist coupling) bending. Edge-twist coupling can increase or decrease the damping of the edgewise mode relative to the reference blade, depending on the operational condition of the turbine. Edge-twist to feather coupling for edgewise deflection towards the leading edge reduces the inflow speed at which the blade becomes unstable. Flap-twist to feather coupling for flapwise deflections towards the suction side increase the frequency and reduce damping of the flapwise mode. Flap-twist to stall reduces frequency and increases damping. The reduction of blade root flapwise and tower bottom fore-aft moments due to variations in mean wind speed of a flap-twist to feather blade are confirmed by frequency response functions.

General information
State: Published
Organisations: Department of Wind Energy, Wind turbine loads & control
Contributors: Stäblein, A. R., Hansen, M. H., Verelst, D. R.
Pages: 343-360
Publication date: 2017
Peer-reviewed: Yes

Publication information
Journal: Wind Energy Science
Volume: 2
ISSN (Print): 2366-7443
Original language: English
Electronic versions:
  wes_2_343_2017.pdf
DOIs:
  10.5194/wes-2016-39
Source: PublicationPreSubmission
Source-ID: 127597193
Research output: Research - peer-review ; Journal article – Annual report year: 2016