SUPPRESSING VORTEX INDUCED VIBRATIONS OF WIND TURBINE BLADES WITH FLAPS

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Due to the flexibility of their blades, it is presumed that modern horizontal wind turbines may be susceptible to Vortex Induced Vibrations (VIV), a phenomenon which could ultimately lead to structural failure of the blade. This statement was supported by the recent high-fidelity simulations of Heinz et al. (2016), where the authors analyzed the DTU 10MW reference wind turbine blade under realistic inflow conditions.

The present paper describes an exploratory work aiming to analyze the impact of trailing edge flaps activation on Vortex Induced Vibrations (VIV) suppression. A computational study of the VIV of the AVATAR rotor blade [Lekou et al. (2015)], a 10MW design suitable for offshore locations, was performed. Trailing edge flaps were introduced in the baseline geometry by means of an innovative Free-Form Deformation (FFD) technique [Figure 1]. A Fluid Structure Interaction (FSI) approach was adopted for the simulations, coupling an Improved Delayed Detached Eddy Simulations (IDDES) flow solver with a beam-based structural model. Initial simulations based on the clean geometry identified significant edgewise VIV for certain free stream velocity and flow inclination angles. The inflow conditions showing the maximum amplitude of blade vibrations were used in order to test several trailing edge flap geometries and operating angles. The best flap configuration found in that parametric study managed to suppress the VIV phenomenon. However, when assessing a wider range of inflow conditions, the amplitudes of vibration of the blade equipped with flaps were found to be equivalent to the ones obtained for its clean counterpart. It is therefore concluded that a re-calibration of the flap operating angle should be required in order to adapt it to the considered wind speed and wind direction.

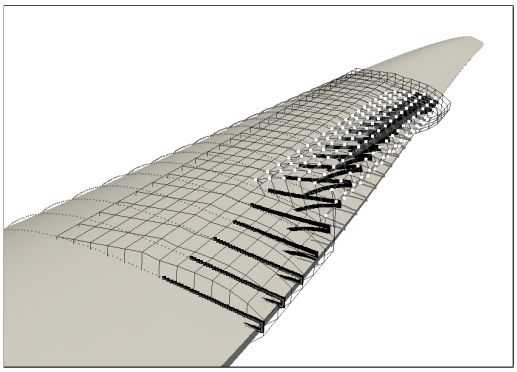

Figure 1: FFD box moving trailing edge (black) into flap position. Only a select few control points (white) are moved, creating a smooth flap-transition along the blade.

References

Heinz, J. C. et al. (2016). Vortex-induced vibrations on a modern wind turbine blade. *Wind Energy*, 19(11):2041–2051.

Lekou, D. et al. (2015). AVATAR Deliverable D1.2: Reference Blade Design. Technical report, ECN Wind Energy, Petten, The Netherlands.