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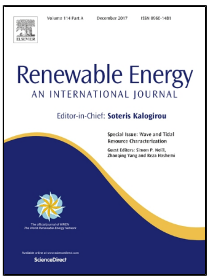

Elastic Actuator Line Modelling for Wake-Induced Fatigue Analysis of Horizontal Axis Wind Turbine Blade

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Abstract (shorter version)

Wake effect causes fatigue increase on the horizontal axis wind turbine (HAWT) blades. This wake-induced fatigue has significant impacts on the efficiency and lifespan of the whole wind farm. However, conventional aeroelastic codes are deficient in terms of turbulent wake modelling and wake interaction modelling. To accurately carry out the aero-elastic simulation in multi-wake operation, an "elastic actuator line" (EAL) model is proposed. Essentially, this model is the combination of the actuator line (AL) wake model and a finite difference structural model. The present research includes two parts. Firstly, the proposed EAL model is outlined. To better establish the two-way coupling between the structural model and the AL model, the transformation of a set of structural equations is presented. Secondly, numerical structural model is established. To verify the present model, the simulated results by EAL for a single NREL 5MW turbine are compared with those obtained with the aeroelastic code FAST. And the comparison shows a good agreement for both high and low TSR (Tip-Speed-Ratio). Another case study for the wake interaction involving two staggered HAWTs is also carried out, which shows that the downstream turbine truly experiences an obvious wake-induced fatigue increase based on our equivalent fatigue load analysis.