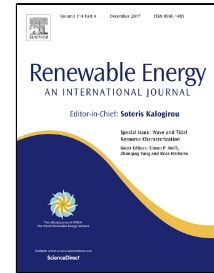


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Elastic Actuator Line Modelling for Wake-Induced Fatigue Analysis of Horizontal Axis Wind Turbine Blade

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1 Abstract (shorter version)

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

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