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AN APPROACH TO THE FATIGUE ANALYSIS OF VERTICAL AXIS WIND TURBINE BLADES*

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Abstract

A cursory analysis of the stress history of wind turbine blades indicates that a single stress level at each wind speed does not adequately describe the blade stress history. A statistical description is required. Blade stress data collected from the DOE/ALCOA Low Cost experimental turbines indicate that the Rayleigh probability density function adequately describes the distribution of vibratory stresses at each wind speed. The Rayleigh probability density function allows the distribution of vibratory stresses to be described by the RMS of the stress vs. time signal. With the RMS stress level described for all wind speeds, the complete stress history of the turbine blades is known. Miner's linear cumulative damage rule is used as a basis for summing the fatigue damage over all operating conditions. An analytical expression is derived to predict blade fatigue life. Input to the blade life expression includes a basic blade S-N curve, RMS stress vs. wind speed data, the probability density function of vibratory stress and the probability density function which describes the wind speed distribution. The implications of the assumptions and the limitations of this approach are discussed.

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