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A Nastran-Based Computer Program For Structural Dynamic Analysis of Horizontal Axis Wind Turbines*

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ABSTRACT

This paper describes a computer program developed for structural dynamic analysis of horizontal axis wind turbines (HAWTs). It is based on the finite element method through its reliance on NASTRAN for the development of mass, stiffness, and damping matrices of the tower and rotor, which are treated in NASTRAN as separate structures. The tower is modeled in a stationary frame and the rotor in one rotating at a constant angular velocity. The two structures are subsequently joined together (external to NASTRAN) using a time—dependent transformation consistent with the hub configuration. Aerodynamic loads are computed with an established flow model based on strip theory. Aeroelastic effects are included by incorporating the local velocity and twisting deformation of the blade in the load computation. The turbulent nature of the wind, both in space and time, is modeled by adding in stochastic wind increments. The resulting equations of motion are solved in the time domain using the implicit Newmark—Beta integrator. Preliminary comparisons with data from the Boeing/NASA MOD2 HAWT indicate that the code is capable of accurately and efficiently predicting the response of HAWTs driven by turbulent winds.

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