ESTIMATION OF UNCERTAIN MATERIAL PARAMETERS USING MODAL TEST DATA[1,2]

Paul S. Veers[3]
Daniel L. Laird[3]
Thomas G. Carne[4]
Mathias J. Sagartz[4]
Sandia National Laboratories
Albuquerque, New Mexico 87185
USA

Abstract

Analytical models of wind turbine blades have many uncertainties, particularly with composite construction where material properties and cross-sectional dimension may not be known or precisely controllable. In this paper we demonstrate how modal testing can be used to estimate important material parameters and to update and improve a finite-element (FE) model of a prototype wind turbine blade. An example prototype blade is used here to demonstrate how model parameters can be identified. The starting point is an FE model of the blade, using best estimates for the material constants. Frequencies of the lowest fourteen modes are used as the basis for comparisons between model predictions and test data. Natural frequencies and mode shapes calculated with the FE model are used in an optimal test design code to select instrumentation (accelerometer) and excitation locations that capture all the desired mode shapes. The FE model is also used to calculate sensitivities of the modal frequencies to each of the uncertain material parameters. These parameters are "estimated," or updated, using a weighted least-squares technique to minimize the difference between test frequencies and predicted results. Updated material properties are determined for axial, transverse, and shear moduli in two separate regions of the blade cross section: in the central box, and in the leading and trailing panels. Static FE analyses are then conducted with the updated material parameters to determine changes in effective beam stiffness and buckling loads.

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3 Wind Energy Technology Department
4 Experimental Structural Dynamics Department