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A CRITICAL REVIEW OF THE BEAM MODELS USED IN THE ANALYSIS OF THE WIND TURBINE BLADES

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Wind energy is, at present, one of the fastest developing energy sectors worldwide and, at the same time, a very effective renewable energy source. Wind energy technology is ranked highly as an energy solution for having clean environment and sustainable development.

Due to their substantial length, wind turbine blades are quite flexible, so that they suffer large displacements and finite rotations under the aerodynamic loads. This fact introduces some nonlinearities in the system of the differential equations which describes the motion of the blades. As a result, the geometry of the blades changes significantly, so one has to look for solutions referred to the deformed configuration of the blade system.

The Fluid Mechanics Department of the Mechanical Engineering School of the NTUA has developed the GAST software to analyze the NREL 5-MW wind turbine. The team has accomplished three different simulations for the structural analysis of the blades:

1. First order beam model (Assumptions Euler-Bernoulli & Timoshenko),
2. Second order Euler-Bernoulli beam model based on the Technical Note of Hodges & Dowell (1974). The resulting equations are valid to second order for long, straight, slender, homogeneous, isotropic beams undergoing moderate displacements. The ordering scheme is based on the restriction that squares of the bending slopes, the torsion deformation, and the chord/radius and thickness/radius ratios are negligible with respect to unity. All the remaining nonlinear terms are retained [1].
3. First order beam model combined with multibody formulation [2].

In addition to the above, the generalized Timoshenko beam model [3] - [5], which is a more advanced simulation, is currently being implemented from the Structural Analysis

Department of the Civil Engineering School of the NTUA, and results are expected to be available at the conference.

Comparisons between the above four models will be also presented at the conference.

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