

**PROCEEDINGS**

# A Novel Finite Difference Method for Solving Nonlinear Static Beam Equations of Wind Turbine Blade Under Large Deflections

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## ABSTRACT

Wind energy is one of the most promising renewable energies in the world. To generate more electricity, the wind turbines are getting larger and larger in recent decades [1]. With the wind turbine size growing, the length of the blade is getting slender. The large deflections of slender wind turbine blade will inevitably lead to geometric nonlinearities [2], e.g. nonlinear coupling between torsion and deflection, which complicates the governing equations of motion. To simplify the solution of the nonlinear equations, in the current research, a novel finite-difference method was proposed to solve the nonlinear equations of static beam model for wind turbine blade under large deflections. Firstly, the governing equations of large wind turbine blade have been derived by Newtonian method, which provide more insight into the mechanism of the structure motion. Secondly, owing to its simplicity, finite-difference and Newton-Raphson method was employed to discretize and solve the proposed equations respectively. Finally, the proposed finite-difference method was successfully validated by the popular FEM-based geometric exact beam theory (GEBT) method, which has more complicated formulation. The results also illustrate that the nonlinear couplings between deflections, extension, and torsion play more important role in the wind turbine blade under large deflections. The current research will provide guidance for the design of next-generation wind turbine blade.

## KEYWORDS

Large wind turbine blade; large deformation; nonlinear beam

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## References:

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