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Dynamic Analysis and Aeroelastic Stability Analysis of Large Composite Wind Turbine Blades

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Summary

In this paper, parametric modeling technique is employed to fast build the three-dimensional finite element shell model of a preliminarily designed large composite wind turbine blade, which is subsequently used in the dynamic analysis and static elastic aeroelastic stability analysis of the blade. In the dynamic analysis, natural frequencies and corresponding modal shapes are obtained for the blade in the case of being still as well as being rotating with rated revolution. For the rotating blade, the stress stiffening effect and spin-softening effect due to the centrifugal forces are taken into account. The static elastic aeroelastic stability analysis, i.e. buckling analysis in this paper, is distinct from its counterparts in adopting the pressure distributions obtained from CFD (Computational Fluid Dynamics) calculations as the loads. An interpolation code is developed to address the mismatch between the unstructured CFD grids of the blade surface and the finite shell elements used in the buckling analysis, allowing mapping the pressures computed by using CFD to the finite element model. Five representative wind speeds are considered in the buckling analysis. It is concluded that structural analysis of large composite wind turbine blades using three-dimensional finite element shell model is beneficial to revealing the relatively weak zones of the blades.