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DESIGN OF FLAT-BACK COMPOSITE BLADE FOR 10MW CLASS WIND TURBINE

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Summary: While the rotor size of wind turbine is expected to increase continuously in future, the composite blades with over 80m length have been developed in worldwide wind industries. Because the blade is one of the most critical components that affects the design loads and cost of the whole wind turbine system, it significantly affects the designs of several other major components, such as the drive train and the tower. Therefore, there have been much research and development efforts to analyze and improve the blade design.

To design a large size wind blade, thick airfoils are desired to increase the sectional stiffness and structural strength of the inboard section of a blade near the root. However thick airfoils generally have a poor aerodynamic performance and were sensitive of premature transition between the airfoils. To solve these problems a flat-back airfoil with a blunt trailing edge has been studied. In the research performed by Sandia National Laboratories, the flat-back airfoils had been produced by the symmetric addition of thickness about the camber line. Thus, these airfoils were different with the conventional truncated airfoils which chop the trailing edge off and thus lose the camber of original airfoil. As a result, the flat-back airfoil has a structural advantage compared to conventional airfoils because it allows a thicker cross section in the inboard section of the blade where highest loads are applied usually. In addition to structural advantages, it has increased maximum lift coefficient and reduced sensitivity to surface soiling.

The most current wind blade is made with composite materials which have high specific stiffness and strength making it possible to design and manufacture safe and lightweight structures. Furthermore, as composites have orthotropic mechanical properties, so a desired structural characteristic can be formed by control the stacking angle and sequence of laminate. Recently, the concept of bend-twist coupling (BTC) has been demonstrated that it can potentially improve the overall performance and reduces its fatigue loading. Bend-twist coupling of blade means the coupling behavior between the bending and torsional deflections due to the composite lamina with fiber angle biased from the blade longitudinal axis. When a gust of wind is blowing to a blade designed in a desired coupled manner, the flapwise bending deflection force the blade to twist along the blade torsional axis, thus this torsional deflection towards feather leads to decrease the angle of attack and consequently to lower the dynamic loads.

In this paper, a flat-back shaped composite blade for 10MW wind turbine was designed and analyzed. To apply BTC design concept, a parametric studies were conducted to optimize the stacking angle, thickness and laminating area of biased carbon UD layer.