Structural Design and Experimental Investigation of A Medium Scale Composite Wind Turbine Blade Considering Fatigue Life

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The aims of this study is to realize the structural design for development of a medium scale E-glass/epoxy composite wind turbine blade for a 750KW class horizontal axis wind turbine system.
In this study, the various load cases specified by the IEC61400-1 international specification and GL Regulations for the wind energy conversion system were considered, and a specific composite structure configuration which can effectively endure various loads such as aerodynamic and centrifugal loads, loads due to accumulation of ice, hygro-thermal and mechanical loads was proposed. In order to evaluate the structure, the structural analysis for the composite wind turbine blade were performed using the finite element method(FEM). In the structural design, the acceptable blade structural configuration was determined through the parametric studies, and the most dominant design parameters were confirmed. In the stress analysis using the FEM , it was confirmed that the blade structure was safe and stable in any various load cases Moreover the safety of the blade root joint with insert bolts, newly devised in this study, was checked against the design load and the fatigue.
The fatigue life for operating more than 20 years was estimated by using the well-known S-N linear damage equation, the load spectrum and Speras empirical equations. With the results obtained from all the structural design and analysis, the prototype composite blades were manufactured. The developed construction process and lay-up molding method through this study were employed to manufacture the prototype blades.
Finally, The full-scale static structural test was performed with the

simulated aerodynamic loads. From the experimental results, it was found that the designed blade had the structural integrity. Furthermore the measured results were well agreed with the analytical results such as deflections, strains, the mass and the radial center of gravity.