Topological Optimization in Wind Turbine Design: Enhancing Performance, Reducing Cost, and Optimizing Substructure Components

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Abstract: With the rapid development of the wind power industry, structural optimization design has become a crucial means to enhance the performance of wind power equipment and reduce costs. Among various optimization techniques, topology optimization is widely applied in wind power equipment design due to its ability to determine the optimal material distribution within a given design domain based on objective functions and constraints. This work explores the typical applications of topology optimization in the field of wind power sector, focusing on the design optimization of jacket structures and nacelle foundations. As the supporting structure for offshore wind power, the jacket requires high strength and stability, which can be achieved through topology optimization for lightweight design, improved structural stiffness, and reduced vibration effects. The nacelle foundation is an important part of the wind turbine unit, and its structural design directly affects the operational stability and fatigue life of the unit. Through topology optimization, material usage can be reduced while ensuring structural safety, thus lowering costs. This work will analyze the specific applications and effects of topology optimization in these key structures and look forward to the development potential of this technology in the design of wind power equipment in the future.