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RELIABILITY-BASED DESIGN OPTIMIZATION OF A WIND TURBINE BLADE USING AN EFFICIENT APPROACH

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Abstract: This paper presents an efficient optimization framework to design composite laminates of a wind turbine blade with loading uncertainties. The 10 MW DTU blade is selected as the reference blade design. A decoupled reliability-based design optimization is developed based on the sequence of a decoupled discrete material optimization and the inverse reliability analysis. This reliability-based design optimization approach is named the sequential optimization and reliability assessment method. The inverse reliability analysis is evaluated using a stochastic response surface method and a first order reliability approach. The design variables are the piecewise patch orientations and material properties of the fiber reinforced composites. The candidate materials of the design space are glass fiber and carbon fiber reinforced polymers. In the design process, the composite laminates of the blade's load-carrying component are designed to minimize the material cost by satisfying the constraints. The compliance and eigenfrequency constraints are analyzed for the optimization framework. The deterministic optimal designs are obtained using the decoupled discrete material optimization approach for baseline comparison. The reliability-based designs are dependent to the uncertainties in loads and the target failure probability. This leads to different optimal layouts compared to the deterministic solutions.