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Sub-scale Inverse Wind Turbine Blade Design Using Bound Circulation[1] CHRISTOPHER KELLEY, JONATHAN BERG, Sandia National Laboratories — A goal of the National Rotor Testbed project at Sandia is to design a sub-scale wind turbine blade that has similitude to a modern, commercial size blade. However, a smaller diameter wind turbine operating at the same tip-speed-ratio exhibits a different range of operating Reynolds numbers across the blade span, thus changing the local lift and drag coefficients. Differences to load distribution also affect the wake dynamics and stability. An inverse wind turbine blade design tool has been implemented which uses a target, dimensionless circulation distribution from a full-scale blade to find the chord and twist along a sub-scale blade. In addition, airfoil polar data are interpolated from a few specified span stations leading to a smooth, manufacturable blade. The iterative process perturbs chord and twist, after running a blade element momentum theory code, to reduce the residual sum of the squares between the modeled sub-scale circulation and the target full-scale circulation. It is shown that the converged sub-scale design also leads to performance similarity in thrust and power coefficients.

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