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Dynamic instability of small-scale wind turbine blades[1] PARIYA POURAZARM, YAHYA MODARRES-SADEGHI, MATTHEW LACKNER, University of Massachusetts Amherst — Future wind turbine blades will become larger, and therefore more flexible. For more flexible blades, the ratio of the estimated critical speed for dynamic instability to the operating speed decreases, and the blades are more susceptible to such instabilities. In the current work, the dynamic instability of a rotating wind turbine blade is studied using a numerical stability analysis and supported by experimental results. For the experimental component of the work, a series of tests were conducted in a wind tunnel. The blades were designed using relatively thin, low Reynolds number airfoils and built using rapid-prototyping methods with a flexible material. As the oncoming wind speed was increased, the beam natural frequencies varied, up to a critical wind speed at which two structural modes coalesced and resulted in a coupled-mode flutter. A theoretical model based on coupled flexural-torsional beam equations subjected to aerodynamic loadings is derived to study the flow-induced instability for the designed blade. The model also predicts the onset of instability at a critical wind speed at which one of the structural modes experiences a negative damping.

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