Flutter Speed Predictions for MW-Sized Wind Turbine Blades

Don W. Lobitz
Sandia National Laboratories*
Albuquerque, New Mexico 87185
dwlobit@sandia.gov

Abstract

Classical aeroelastic flutter instability historically has not been a driving issue in wind turbine design. In fact, rarely has this issue even been addressed in the past. Commensurately, of the wind turbines that have been built, rarely has classical flutter ever been observed. However, with the advent of larger turbines fitted with relatively softer blades, classical flutter may become a more important design consideration. In addition, innovative blade designs involving the use of aeroelastic tailoring, wherein the blade twists as it bends under the action of aerodynamic loads to shed load resulting from wind turbulence, may increase the blades proclivity for flutter. With these considerations in mind, it is prudent to revisit aeroelastic stability issues for a MW-sized blade with and without aeroelastic tailoring. Focusing on aeroelastic stability associated with the shed wake from an individual blade turning in still air, the frequency-domain technique developed by Theodorsen for predicting classical flutter in fixed wing aircraft has been adapted for use with a rotor blade. Results indicate that the predicted flutter speed of a MW-sized blade is slightly greater than twice the operational speed of the rotor. When a moderate amount of aeroelastic tailoring is added to the blade a modest decrease (12%) in the flutter speed is predicted. By comparison, for a smaller rotor with relatively stiff blades, the predicted flutter speed is approximately six times the operating speed. When frequently used approximations to Theodorsen's method are implemented, drastic under-predictions result, which, while conservative, may adversely impact blade design. These under-predictions are also evident when this MW-sized blade is analyzed using time-domain methods.

---

* Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy under Contract DE-AC04-94AL85000.