Abstract

This study addresses the performance and behavior of the multi-cross-section Horizontal Axis Wind Turbine (HAWT) blade design with and without fences. The FX66-S-196 V, FX63-137 S, and SG6043 supercritical airfoils are used and distributed along the blade radius. In addition, the NACA 4412 single-cross-section HAWT blade has with same dimensions is used to compare the behaviors and overall performances for all the blades. Numerical analyses are performed using self-code (FORTRAN.90) and Q-Blade software based on Blade Element Momentum (BEM) theory. Besides, the experimental work with three multi-cross-section blades are designed using Solidworks and 3D printer with polylactic acid. The multi-cross-section HAWT blades showed a good performance compared with the single- cross-section NACA 4412 blade, with an approximately 8% increase in power coefficient, for a miniature wind turbine (1.27 m diameter 500 W output power). The fences were designed using boundary layer theory and installed on multi-cross-section blades, whereas locations of fences over blades are determined experimentally. Red strings are placed along the blade radius and show the flow paths and important fences installations on the blades. The blades with fences showed high performance, with increasing of 16% in total power coefficient and high flutter stability.