PERFORMANCE OF AN ADAPTIVE PITCH AXIAL-FLOW TURBINE IN TURBULENT INFLOW

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Marine hydrokinetic turbines are typically placed in dynamic, energy-dense locations and are subject to complex spatially and temporally varying flow. To withstand the associated forces and survive in the harsh offshore environment, marine turbine blades are increasingly constructed from fiber reinforced polymer (FRP) composites, which provide superior strength- and stiffness-to-weight ratios and improved fatigue resistance compared to traditional metallic alloys. Furthermore, previous studies have demonstrated the possibility of tailoring the anisotropic properties of FRP composites to create a load-dependent adaptive pitch blade, where elastic blade deformations vary dynamically with loading condition. Such an adaptive mechanism has been shown to improve system performance in quasi-steady flow conditions [1]; however, a marine turbine will realistically spend much of its operating life in varying levels of turbulent inflow. The ability of an adaptive composite blade to passively adjust to the instantaneous flow and shed excess loading may also be a valuable asset under turbulent conditions.

To investigate this possibility, the experimental study presented here will explore the ability of a flume-scale axial-flow adaptive pitch turbine to respond to coherent vortices introduced to the inflow. The behavior of the turbine with adaptive pitch blades will be compared to the same turbine with non-adaptive composite blades in flows with various scales of induced coherent vortices. Blade loading, system performance, and wake characterization between the two systems will be analyzed in order to evaluate the potential benefits of the use of adaptive pitch turbine blades in fully turbulent flow. A discussion of results will be included assessing the relative benefits of the adaptive pitch system with respect to structural reliability, system performance, and array planning.

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REFERENCES

[1] Barber, Ramona B, Hill, Craig S, Wiebe, Richard, Aliseda, Alberto and Motley, Michael R. "Flume-Scale Testing of an Adaptive Pitch Marine Hydrokinetic Turbine." *Composite Structures* Vol. 168 (2017): pp.465-473.

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