IMPACT OF PYLON FAIRING PROFILE ON THE ENERGY AVAILABLE TO DOWNSTREAM ROTOR TIDAL TURBINES

ASHWIN VINOD*[1], ARINDAM BANERJEE*[2] AND JONATHAN COLBY#[3]

*Mechanical Engineering and Mechanics, Lehigh University, 19 Memorial Drive West, Bethlehem, PA 18015
#Verdant Power, Inc., PO Box 282, New York, NY 10044
[1]asv312@lehigh.edu, [2]arb612@lehigh.edu, [3]jcolby@verdantpower.com

Tidal stream turbine designs where the flow encounters the upstream pylon before reaching the rotor plane are known to encounter a velocity deficit at the rotor plane, thereby reducing the energy extracted from the flow. Also, the pylon wake increases load fluctuations on the blades thereby accelerating fatigue damage to the blades and other turbine components[1, 2]. A plausible solution to this problem is to use pylon fairings[3]. However, there is a paucity of data sets that could be used to answer questions concerning the influence of pylon fairing shapes on the flow recovery and energy captured by a downstream rotor as well as their impact on long-term fatigue loads. Laboratory experiments were performed to study the velocity deficit caused by various pylon configurations. A closed loop water tunnel facility at Lehigh University (Bethlehem, PA) equipped with a 10-axis active grid type turbulence generator[4, 5] was used with a scaled model of a pylon at $Re \sim 2{\times}10^4$. Figure 1 shows a schematic of the experimental setup. A circular cylinder (Diameter=1.9") was considered as the baseline pylon. Modified pylons included fairings composed of straight, convex, and concave plates attached downstream of the cylinder. A pylon with fairings both upstream and downstream (referred to as the Double Pylon) was also used. The designs were tested at yaw of 15° and at two levels of elevated free stream turbulence intensities that mimic tidal energy sites (6% and 18%). Elevated turbulence was found to alleviate mean velocity deficit in the wake by 23% (at most) resulting in an increase in power capture by 1%. Of all modified pylons, the double pylon seemed to be the most effective, with a yawed double pylon being even more effective by increasing power capture by 2.25% (Figure 2).

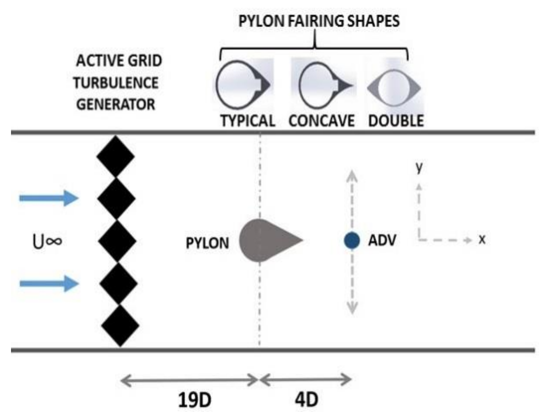

FIGURE 2. SCHEMATIC OF THE EXPERIMENTAL SETUP AND PYLONS

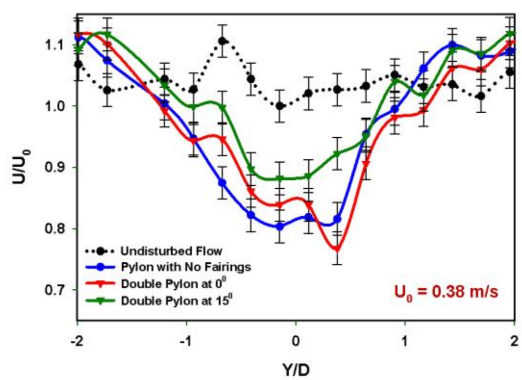

FIGURE 1. WAKE DEFICIT COMPARISON OF DOUBLE PYLON TO BASELINE PYLON

REFERENCES

1. Frost, C., et al., *The effect of tidal flow directionality on tidal turbine performance characteristics.* Renewable Energy, 2015. **78**: p. 609-620.
2. Chamorro, L., et al., *Effects of energetic coherent motions on the power and wake of an axial-flow turbine.* Physics of Fluids, 2015. **27**(5): p. 055104.
3. Assi, G.R., P.W. Bearman, and M.A. Tognarelli, *On the stability of a free-to-rotate short-tail fairing and a splitter plate as suppressors of vortex-induced vibration.* Ocean Engineering, 2014. **92**: p. 234-244.
4. Lawrence, A., A. Vinod, and A. Banerjee. *Effect of Free Stream Turbulence on Tidal Turbines. Part I - Blade Hydrodynamics and Loading*. in *12th European Wave and Tidal Energy Conference*. 2017. Cork, Ireland.
5. Vinod, A., A. Lawrence, and A. Banerjee. *Effect of Free Stream Turbulence on Tidal Turbines. Part II - Turbine Performance and Near Wake Characteristics*. in *12th European Wave and Tidal Energy Conference*. 2017. Cork, Ireland.

Preprint submitted to 2018 6th Annual Marine Energy Technology Symposium.
Received February 14, 2018.