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Development and demonstration of an emergent net shape fabricated three blade composite one piece rotor for CAPEX and OPEX reductions

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Marine hydrokinetic (MHK) turbines have shown promise as a method for harvesting energy from natural waterways. However, excessive fabrication and assembly and high life-cycle costs often preclude implementation of these energy harvesting devices. As such, our research is focused on mitigation of the implementation challenges by development and demonstration of a novel low-cost, net shape fabricated single piece composite three-blade MHK turbine rotor to minimize both Capital Expenditures (CAPEX) and Operational Expenditures (OPEX) to enable cost of energy improvements. We were able achieve these cost reductions by leveraging our successfully demonstrated rapid prototyping protocol, underpinned by our team-based concurrent engineering approach, whereby we incorporate all key technology disciplines including materials, design and analysis, manufacturing, non-destructive inspection, and test and evaluation from rotor concept formulation through delivery of the single piece composite rotor prototype. Our presentation provides a summary of the three key emergent technologies associated with our prototype development and demonstration evolution: 1) design for turbine rotor manufacturability using computational fluid dynamics and finite element analysis; 2) single piece composite turbine rotor net shape fabrication; and 3) coupon and prototype threshold fatigue testing to ensure rotor structural robustness. This innovative team-based concurrent engineering approach enabled us to reduce CAPEX by eliminating complex assemblies and rotor machining while mitigating OPEX by use of non-corrosive e -glass/epoxy composite materials and implementing our state -of-the-art threshold fatigue design protocol to prevent onset of material degradation over the life of the MHK turbine rotor.

Biography

Dr. Koudela has led the design, fabrication and demonstration of multiple composite and hybrid composite prototypes for operational evaluation and has taught courses in composites, structural analysis and finite element analysis at the Pennsylvaniate State University. Dr. Koudela has authored or co-authored 23 refereed journals and 43 technical proceeding articles and serves as a technical reviewer for the Journal of Composite Materials, Journal of Composites Technology and Research, ASTM, and ASME. Dr. Koudela was awarded the Navy Meritorious Civilian Service Award and was a co-recipient of the Defence Manufacturing Technology (ManTech) Achievement Award by the U.S. Office of Naval Research.

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