Characterization of Debond Toughness of Sandwich Composites for Ocean Current Turbine Rotor Blades

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A study of sandwich composites has been conducted to further understand how material selection and composite manufacturing choices impact Ocean Current Turbine (OCT) rotor blade strength. Composite sandwiches were evaluated since they are becoming a suitable candidate for OCTs rotor blades. Previous fatigue and life estimate studies of OCT rotor blades have shown that face/core delamination is the dominant failure mode of sandwich composites [1]. Therefore, composites containing carbon/epoxy face sheets and syntactic and polyurethane foam cores were fabricated, and their debond toughness was quantified. To further study the role of face/core bonding conditions, composites with a chopped strand mat (CSM) inserted at the face/core interface were manufactured and tested. Material parings were manufactured at Florida Atlantic University using a vacuum assisted resin transfer molding (VARTM) process. The material parings were chosen coincide with the Southeast National Marine Renewable Energy Center's (SNMREC) and IHI Corporation's current OCT rotor blade designs [2].

To quantify the deboned toughness of the material parings, a single cantilever beam (SCB) testing method was utilized. In SCB tests, the face sheet separates from the core by propagating a crack along the interface during cyclic loading (Figure 1). The resulting load-deformation and measured crack lengths are used to calculate the mode-I fracture toughness. Material pairings with a higher debond toughness coincide with a longer lifespan during sea operation, ultimately reducing maintenance requirements. Results indicate that the neat sandwich composites with a syntactic and polyurethane foam core has an average debond toughness of 177 J/m^2 and 175 J/m^2, respectively. When the CSM was introduced at the interfaces, the syntactic and polyurethane sandwich composites exhibit a debond toughness of 203 J/m^2 and 199 J/m^2 respectively. Indicating a 14.4 % increase and 13.6 % increase in debond toughness with a CSM interface layer on syntactic and polyurethane sandwich composites, respectively.

Figure 1: Single Cantilever Beam Test

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