INVESTIGATING THE TIME-DEPENDENT AND THE MECHANICAL BEHAVIOR OF WOOD PLASTIC COMPOSITE LUMBER MADE FROM THERMALLY MODIFIED WOOD IN THE USE OF MARINE AQUACULTURAL STRUCTURES

By Murtada Abass A Alrubaie

Dissertation Co-Advisors: Dr. Roberto Lopez-Anido, P.E.

Dr.Douglas J. Gardner

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Wood Plastic Composite (WPC) lumber based on a patent-pending formulation is being explored for use in the manufacture of an aquaculture fish cage structure (Aquapod net pen cage), as an alternative to the current high density polyethylene (HDPE) lumber. The use of WPC lumber in structural applications in marine environments requires a comprehensive effort to understand the material viscoelastic behavior and the structural performance of the WPC lumber in marine environments where the WPC lumber is exposed to the combined effect of saltwater immersion and temperature (hygrothermal). The evaluation of the viscoelastic behavior of WPC lumber in marine environments was conducted through series of short-term of dynamic mechanical and thermal analysis (DMTA) creep and creep-recovery experiments, where the WPC specimens were preconditioned and tested under the combined effect of temperature and water immersion at different target levels of stress. Long-term creep experiments of WPC and HDPE lumber under the same controlled conditions and stress levels are necessary to evaluate

and compare the viscoelastic behavior of WPC and HDPE lumber. An understanding of the structural behavior of WPC lumber in an aquaculture structure was advanced through testing components (triangular panels) from a spherical shape geodesic frame (Aquapod) structure made from WPC and HDPE lumber, respectively. The hygrothermal viscoelastic response of WPC lumber was characterized and modeled. The experiments included measuring 30 minutes of creep and 30 minutes of creep-recovery on the specimens immersed in saltwater and distilled water at two different levels of flexural stresses (9% and 14% of the ultimate flexural strength, Fb) and three temperature values (25, 35, and 45℃). The creep strain fractional increment (CSFI) of the WPC in this study under all conditions was 86% lower than the CSFI of the WPCs reported in previous studies. The WPC material in this study exhibited linear viscoelastic and nonlinear viscoelastic behavior based on the effect of temperature only, and the combined temperature and water immerstion effect, respectively. The 180-day creep behavior of the WPC and HDPE lumber in flexure was characterized and compared for WPC and HDPE lumber (with 853 mm support span) subjected to three levels of creep stress: 7.5, 15, and 30% of the ultimate flexural strength (Fb). The 180-day creep deformation of HDPE specimens was six times higher than the creep deformation of WPC specimens at the 30% creep stress level. A power law model was used to describe 180-day creep deflection of WPC lumber beams. Modeling results predicted that the strain to failure in the HDPE and WPC lumber would occur in 1.5 years and 150 years at a flexural stress of 30% Fb, respectively. A pair of connected triangular panels of the Aquapod structure with and without wire mesh made from WPC and HDPE lumber were tested in compression to evaluate and compare the buckling capacity of the panels, respectively.