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THE DESIGN AND ANALYSIS OF A FULL SCALE  
COLLISION TOLERANT PILE STRUCTURE

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THESIS

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ABSTRACT

THE DESIGN AND ANALYSIS OF A FULL SCALE  
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This thesis involves the design and analysis of a prototype full scale collision tolerant pile structure (CTPS). The CTPS is designed to be used as a supporting structure for aids to navigation (ATONs) in shallow ship channels where exact location of the channel is critical. The currently used wooden piles are often destroyed when involved in collisions with barges or ships, and their replacement is time critical and expensive.

The CTPS design involves a single rigid 37 foot, 18 inch diameter pile installed in a design water depth of 20 feet. The pile is hinged at the mudline with a fully articulated omnidirectional hinge that is capable of 90° angular displacements from vertical. When a collision is sustained the CTPS deflects away from the upright position. The pile then returns to vertical with the aid of an internal pre-loaded spring system and both internal and external buoyancy.

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The full scale CTPS design is based on the results of previous modeling and testing done on both 1/15th and 1/4th scale models. The results of this work were used to verify computer models of the system which simulate the pile dynamics during collisions and under both normal and extreme environmental loadings. The environmental loadings that the CTPS system must withstand while remaining nearly vertical, are normal intensity winds, waves, and currents. The CTPS must also survive hurricane intensity wind, waves, and currents.

Computer models were used to aid in the final full scale design. Use of the programs enabled the simulation of the reactions and pile response to large collision and recovery, and storm loadings for the 37 foot prototype. This enabled designing a suitable structure that is capable of sustaining a minimum of five barge collisions; any one of which would destroy a traditional wooden navigation pile.

In order to survive the forces of collision and recovery, a site specific soil analysis and design is necessary for each driven foundation. While the concept of the full scale CTPS remains the same as the models, added design criteria such as scale-up, economy, and ease of manufacture have led to this final prototype design.