Light-Weight Materials Selection for High-Speed Naval Craft

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A decision analysis study was conducted on the process of materials selection for high-speed naval craft using the Modified Digital Logic (MDL) method proposed by B. Dehgham-Manshadi et al in Materials and Design, 28(1): pp. 8-16, 2005. The MDL method is based on the Weighted Properties Method (WPM) for decision making but differs by comparing only two attributes at a time. The MDL method has already been proven to be a reliable decision analysis tool in mechanical design in other areas of research, thus it was the goal of this thesis to evaluate and analyze the MDL method for material selection in high-speed naval craft design. The potential materials for evaluation were selected using Naval Sea Systems Command (NAVSEA) references for several materials in use, or being evaluated, for light weight naval construction. The study also introduced the potential use for Ultra High-Performance Concrete Composite (UHP2C) DUCTAL © material application in Naval Architecture.

Using Ashby's Material Selection Charts and the MDL method, a step by step material selection process was outlined. Furthermore, a comparative analysis of the properties and basic structural qualities between the materials was completed and then an evaluation was done to optimize material selection. The results showed how using a simplified digital logic approach in conjunction with Ashby's material selection process can provide a comprehensive tool designed specifically for light-weight material optimization. The results also showed how new materials and/or new applications of existing materials can be quickly evaluated for potential use in naval architecture.

Non-Linear Rolling of Ships in Large Sea Waves

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The United States Navy has taken a new interest in tumblehome hulls. While the stealth characteristics of these hull forms make them attractive to the Navy, their sea keeping characteristics have proven to be problematic. Normal approximations of sea keeping characteristics using linear differential equations with constant coefficients predict a very stable platform, while observations in model tests show a ship that is prone to extreme roll transients. This thesis examines a simple method of producing a non-linear simulation of roll motion using a tumblehome hull provided by the Office of Naval Research. This research demonstrates the significant difference that a variable restoring coefficient introduces into a hull's seakeeping characteristics.