Thesis Project Portfolio

Concrete Canoe Design Competition - Design Report Draft II

(Technical Report)

Paddling Towards Sustainability: Redesigning Concrete Canoes for the Environment

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring, 2024

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Table of Contents

Sociotechnical Synthesis

Increasing demands for construction and the surge in urbanization amplified the environmental concerns associated with concrete, primarily due to the significant carbon footprint and resource consumption associated with production. This research investigated the environmental implications of concrete production and the potential benefits of utilizing greener materials and techniques in concrete mix design. Specifically, it focused on the '*Hoos on the Move* concrete canoe project as a case study to understand the feasibility and benefits of alternative materials and techniques in creating a concrete canoe. The study also aimed to evaluate the social and technical dimensions of sustainability and analyze the impact of incorporating these practices on the construction industry.

The research was grounded in the interdisciplinary field of Science, Technology, and Society (STS). Through the lens of STS, this research was informed by Thomas Seager's work, particularly Sustainable Engineering Science for Resolving Wicked Problems (2011), which emphasized the integration of social and technical considerations in addressing complex sustainability challenges. Seager defined 'wicked problems' as issues that were inherently resistant to straightforward solutions due to their multifaceted nature. The Concrete Canoe Competition, being an intricate and interconnected challenge, embodied the characteristics of a wicked problem. To adhere to the client's needs, our Capstone's research was to find innovative solutions in concrete canoe design to meet the annual requirements of the American Society of Civil Engineers Concrete Canoe Competition. The hope was that the design would be reproducible for 100 prototypes. By recognizing the complex nature of wicked problems, this research identified innovative solutions that prioritize sustainability without compromising structural integrity or performance. Understanding the trade-offs between environmental sustainability and practical feasibility, the study recognized solutions that prioritize sustainability without sacrificing functionality. It also examined the role of interdisciplinary collaboration and the importance of diverse perspectives in finding effective solutions to complex problems.

Through interviews with mix design captains and document analysis, insights into current practices, challenges, and areas for improvement in sustainable concrete mix design emerged. This research found that interdisciplinary collaboration and comprehensive sustainability approaches led to superior concrete mixes and competition placements, balancing performance with environmental stewardship. The top 3 performing teams all emphasized the importance of the three pillars of sustainability. The findings of this research have broad implications for the construction industry and beyond. By identifying best practices and potential areas for improvement,

the study contributes to a deeper understanding of the social and environmental implications of concrete production. By integrating sustainability into engineering practices, the research aims to promote more environmentally responsible approaches to construction and contribute to the global effort to reduce carbon emissions and mitigate climate change.