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## Ph.D. DISSERTATION DEFENSE

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**Degree:** Doctor of Philosophy
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**Title:** AI-Assisted Development and Characterization of High-Performance Fiber-Reinforced Cementitious Composite

**Chairperson:** Dr. Weina Meng, Department of Civil, Environmental, and Ocean Engineering, School of Engineering and Science

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## ABSTRACT

High-Performance Fiber-Reinforced Cementitious Composite (HPFRCC) represents a family of advanced composite materials with remarkable mechanical properties and durability, but their design and characterization tasks involve unique challenges. Recently, the advances in machine learning techniques have offered new opportunities. This dissertation explores the application of machine learning techniques in the design and characterization of HPFRCC. The application of machine learning to the design of HPFRCC is proposed based on a prediction-optimization-interpretation framework. Machine learning models, including automated machine learning, are employed to predict mechanical strengths, while evolutionary algorithms optimize HPFRCC performance with respect to cost and carbon footprint. To enhance interpretability, a knowledge graph is developed to explain machine learning predictions. Further, methods for property prediction and material design are extended to incorporate fresh properties and crack behavior. An in-situ monitoring method is proposed for assessing the fresh properties of HPFRCC, leveraging a time-series deep learning model. A comprehensive framework is also introduced to identify and quantify dense microcracks in HPFRCC, addressing challenges such as data scarcity and quality improvement. Together, these contributions provide a robust foundation for advancing the design, performance, and sustainability of HPFRCC through the integration of machine learning.