Research Project Name: Efficient system reliability assessment of shoreline seawalls: Applications to SEAHIVE (UM)

Improving the Durability and Extending the Life of Transportation Infrastructure

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Project Description: Seawalls play a critical role in protecting coastal transportation systems from erosion, flooding and storm surges. Yet their performance is deteriorating due to changes in structural capacity and increasing external demands, posing growing threats to coastal safety. Evaluating the reliability and risk of seawalls along the shoreline is essential for informed maintenance and repair decisions. However, the large scale of shoreline seawalls and the complex coastal and geotechnical conditions in Miami present significant challenges for system reliability analysis. This is a collaborative research project conducted in partnership with Texas State University. The objective of this research project is to develop an efficient and practical framework that integrates interdisciplinary expertise in geotechnical asset management, seawall design and construction, and reliability analysis to perform system reliability analysis of shoreline seawalls.

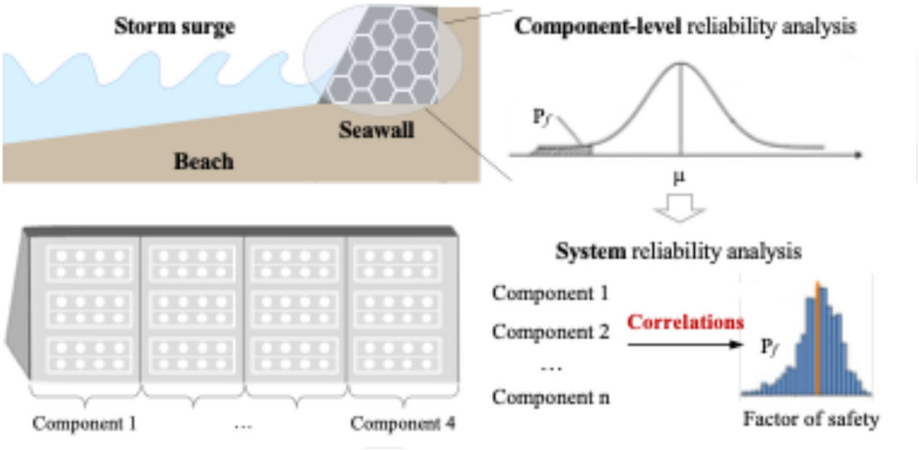

Figure 1. Illustration of reliability analysis of shoreline SEAHIVE®

The proposed project builds on two lines of prior works. First, an effective and well-defined inspection rating system was developed to evaluate the conditions of mechanically stabilized earth (MSE) walls at Texas State University. Second, SEAHIVE®, a novel seawall composed of concrete perforated hexagonal prisms, was developed at the University of Miami and has been implemented in the Miami area for its ability to dissipate wave energy and protect habitats. Leveraging these advances, the proposed project will establish a unified framework for reliability assessment of shoreline seawalls.

The project consists of two phases: component-level and system-level reliability analysis. At the component level, we will develop an efficient and effective method to evaluate the reliability

analysis of individual SEAHIVE® components. First, using available analytical models and experimental data, we will define limit states that specify the conditions under which SEAHIVE® components perform adequately or fail. Second, the inspection rating method originally developed for MSE walls will be recalibrated for SEAHIVE® in the Miami area, following procedures established in prior work. Finally, these calibrated ratings will then serve as inputs to the defined limit states, enabling the calculation of reliability indices. The expected outcome of this phase is a practical guideline for engineers to quickly rate the seawall and determine the component reliability index.

Since seawalls function as interconnected systems rather than isolated units, the next phase is system-level analysis. Specifically, we will elicit statistical correlations in seawall deterioration and soil conditions across different locations using inspection, measurement, and simulation data. An efficient system reliability analysis will then incorporate these correlations into component-level reliability analysis to compute the overall reliability index of seawalls along the shoreline. Together, the two phases will yield a practical decision support tool to efficiently inspect the shoreline seawalls and estimate the system reliability index in support of risk management and maintenance prioritization for seawalls.

US DOT Priorities: *Section left blank until USDOT's new priorities and RD&T strategic goals are available in Spring 2026.*

Outputs: The project will produce a decision support tool to enable rapid reliability assessment and targeted maintenance planning for SEAHIVE®. To promote the tool, we will establish a user-friendly interface that can allow inspectors to easily input inspection results, query existing inspection log, and identify the most vulnerable section along the shoreline. During the development, we will actively communicate with asset managers and seek their feedback.

Outcomes/Impacts: Coastal infrastructure is susceptible to erosion, flooding, and storm surges, causing millions of dollars in damages. A well-functioning seawall is essential to protect this infrastructure. This project will deliver a reliability-based decision support tool that guides inspection and maintenance of SEAHIVE® seawalls in a cost-effective manner. Technology transfer will focus on demonstrating the inspection rating method and the decision support tool to agencies and practitioners responsible for coastal infrastructure management. Initial efforts will center on SEAHIVE® installations in the Miami area. We will showcase how rapid inspection rating is done and how the results can be translated into reliability indices to support maintenance decisions. The PIs will also engage state and local agencies such as FDOT, Miami-Dade County, and municipal governments, as well as critical stakeholders from ports and beaches. Although developed with SEAHIVE® as the case study, the framework is adaptable to other seawall systems. We will promote the use of the decision support tool as an enabler for risk-informed infrastructure management to protect coastal transportation infrastructure.

Final Research Report: URL to final Report will be provided upon completion.