Transportation Consortium of South Central States

Key Points

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18STTSA04

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Lead Institution:
University of Texas at San Antonio

Funds Requested to UTC:
$50,000

Funding Source(s):
Tran-SET
University of Texas at San Antonio

Total Project Cost:
$100,000

Structural Vulnerability of Coastal Bridges Under Extreme Hurricane Conditions

Brief Project Description

The main objective of this study is to predict the structural vulnerability of coastal bridge structures to hydrodynamic loads generated under extreme hurricane conditions along the Texas-Louisiana coastline. This study will analyze the most common bridge types with the aim of identifying structures that are resilient to hurricane waves and storm surge. Finite element based simulations will be conducted to quantify the magnitude of the hydrodynamic loads under different hurricane sea states. This information will be used to develop structural vulnerability curves and propose strategies that minimize structural damage during an extreme hurricane event.

Problem Statement

The strategies adopted to cope with extreme hurricane and tsunami events in the United States have been reactive rather than proactive. Studies indicate the cost of repairing and replacing bridges damaged during Hurricane Katrina exceeded $1 billion. The most severe damage consisted of superstructure collapse due to unseating of the deck, caused by the combined actions of storm surge and hydrodynamic forces from waves. This type of failure was observed both in bridges with integral and non-integral supports. In some instances uplift forces were large enough to exceed the weight of the superstructure and cause the failure of the connection at the support. It was also observed that in some cases, shear keys were sufficient to prevent unseating of the superstructure.

While reactive actions are necessary after extreme events, the frequency and intensity of recent hurricanes demonstrated the need of taking proactive actions to prevent major damages. A crucial step toward addressing this need is to accurately quantify the vulnerability of coastal infrastructure to extreme hurricane storms.

Objectives

The main goal of this study is to evaluate the structural vulnerability of coastal bridge structures to hydrodynamic loads generated under extreme hurricane conditions. The technical objectives include to:

- Identify bridge configurations and types of bridge supports most susceptible to severe damage due to extreme hurricanes and storm surge events.
- Develop strategies that minimize structural damages during extreme hurricanes and storm surges.

Intended Implementation of Research

The implementation phase of the project will consist of outreach and educational activities, including:

- Elaborate a short document aimed at DOT and practicing engineers detailing research findings
- Present research results from the project in technical meetings
- Develop of online-learning material (YouTube videos and webinar)
- Improve engineering curriculum at the University of Texas at San Antonio (UTSA).

The short technical document will contain the developed structural vulnerability curves as a function of different hurricane intensities and the identified hurricane hazard zones. The research team will make presentations of the research findings at local and state meetings of the Structural Engineering Association of Texas. The research team will also make presentations at national conferences and relevant technical committees.

YouTube videos on best practices for modeling fluid-structure interaction in bridges along with a tutorial that shows the basic principles for performing these simulations will be developed. Findings will support curriculum improvements at the UTSA. The research team will al develop educational modules to discuss this project to undergraduate and graduate students in their institutions.

Anticipated Impacts/Benefits of Implementation

The potential impact of this study includes:

- Contribute to the resiliency of the transportation networks.
- Ensure the reliability of transportation routes needed to evacuate large populations along the coast during a hurricane.
- Minimize the effects of extreme hurricanes on the economies in the US and along the Texas-Louisiana coastline.
- Facilitate post-disaster recovery efforts and restore economic activity.
- Provide students an additional edge in a highly competitive job market and continuing education opportunities for practicing engineers.

Weblinks:

http://transet.lsu.edu/research/research-in-progress/

https://rip.trb.org/View/1505508