



Abstract

A number of U.S. coastal bridges have been destroyed by hurricanes, including three highway bridges in Mississippi and Louisiana during Hurricane Katrina (2005). This paper addresses three fundamental questions on the coastal bridge failures: (1) what were the hydrodynamic conditions near the failed bridge during the hurricane; (2) what was the cause of the bridge collapse; and (3) what was the magnitude of the hydrodynamic loading on the bridge under the extreme hurricane conditions. Guided by field observations of winds, waves, and water levels, two numerical models for storm surges and water waves are coupled to hindcast the hydrodynamic conditions. Fairly good agreement between the modeled and measured high watermarks and offshore wave heights is found, allowing an estimate of the surge and wave conditions near the bridges in nested domains with higher resolutions. The output of the coupled wave-surge models is utilized to determine the static buoyant force and wave forces on the bridge superstructure based on empirical equations derived from small-scale hydraulic tests for elevated decks used in the coastal and offshore industry. It is inferred that the bridge failure was caused by the wind waves accompanied by the storm surge, which raised the water level to an elevation where surface waves generated by strong winds over a relatively short fetch were able to strike the bridge superstructure. The storm waves produced both an uplift force and a horizontal force on the bridge decks. The magnitude of wave uplift force from individual waves exceeded the weight of the simple span bridge decks and the horizontal force overcame the resistance provided by the connections of the bridge decks to the pilings. The methodology for determining the hydrodynamic forcing on bridge decks can be used to produce a preliminary assessment of the vulnerability of existing coastal bridges in hurricane-prone areas.

Get full access to this article

View all available purchase options and get full access to this article.

 GET ACCESS

Acknowledgments

The study was supported in part by the National Science Foundation (Grant No. NSF0652859) and the Federal Highway Administration (DTFH 61-03-C0015). Collaborations with Scott Douglass at the University of South Alabama are sincerely acknowledged. Candace Wright prepared the AutoCAD drawings. Permission to use the field observations collected by the federal agencies as well as bridge information provided by the Mississippi Department of Transportation is appreciated. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the writers and do not necessarily reflect the views of the National Science Foundation or the Federal Highway Administration.

References

ASCE Technical Council on Lifeline Earthquake Engineering (ASCE TCLEE). (2006). "Performance of transportation systems during Hurricane Katrina." *Draft Rep.*, Reston, Va.

[Google Scholar](#)

Blain, C. A., Westerink, J. J., and Luettich, R. A. (1994). "The influence of domain size on the response characteristics of a hurricane storm surge model." *J. Geophys. Res., [Oceans]*, 99(9), 18467–18479.

[Crossref](#) | [Google Scholar](#)

Booij, N., Ris, R. C., and Holthuijsen, L. H. (1999). "A third-generation wave model for coastal regions. Part 1: Model description and validation." *J. Geophys. Res., [Oceans]*, 104(4), 7649–7666.

[Crossref](#) | [Google Scholar](#)

Bossak, B. H. (2005). "Katrina's wake." *EOS Trans. Am. Geophys. Union*, 86(27), 333–334.

[SHOW ALL REFERENCES](#)

Recommended

Journal of Geotechnical and Geoenvironmental Engineering | Article | May 2008

Hurricane Katrina Storm Surge Reconnaissance

Chapter | April 2012

The Hurricane Katrina Storm Surge in Mississippi

Chapter | April 2012

Coastal-Change Impacts during Hurricane Katrina: An Overview

Chapter | April 2012

Lessons in Bridge Vulnerability from Hurricane Katrina: Reconnaissance Findings and Analysis of Empirical Data

Chapter | April 2012

A Comparison between High Water Marks and Hydrograph Recordings in Hurricane Rita

[View full text](#) | [Download PDF](#)