Florida Department of Transportation Research

Development of FB-MultiPier Dynamic Vessel-Collision Analysis Models, Phase 2

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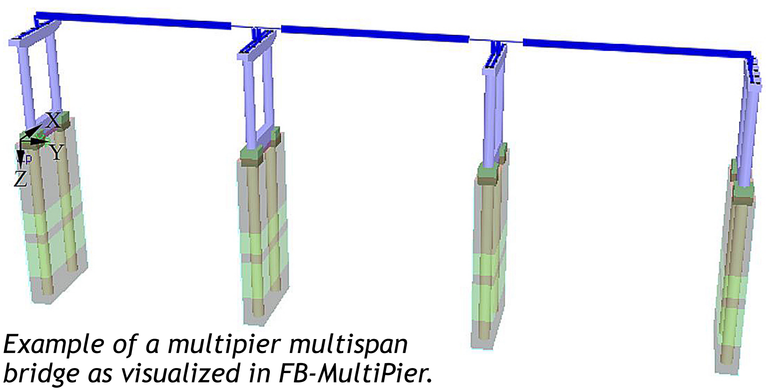
When collisions between large vessels and bridge supports occur, they can result in significant damage to bridge and vessel. These collisions are extremely hazardous, often taking lives on the vessel and the bridge. Direct costs of repair and liability are high; add to that secondary costs of delays and congestion due to rerouting traffic to other bridges, which may be distant and not designed for the increased traffic loads. Understanding these collisions in detail and developing design tools that incorporate this knowledge is an important and continuing effort.



Example of a multipier multispan bridge as visualized in FB-MultiPier.

FB-Multipier (FBMP), the software advanced in this project, results from a ten-year collaboration between Florida Department of Transportation (FDOT) and University of Florida (UF) researchers. FBMP analyzes the supporting piers of multispan bridges, including the interaction among bridge components and between bridge components and supporting soil. This work advanced the state-of-the-art in numerical modeling of impact design loads and predictions of bridge response.

The collision forces are complex: they increase linearly up to a certain force, but beyond that, the structure's reactions become highly nonlinear, generating very large datasets and computational needs that may be impractical in a typical design setting. Therefore, in this project, researchers focused on new numerical methods for FBMP — based on pioneering experimental and numerical studies conducted by the UF team. The additions give FBMP the capability of predicting bridge response within reasonable margins of error.

Specifically, the new methods are coupled vessel impact analysis (CVIA) and the one-pier two-span (OPTS) bridge model. Both were incorporated into FBMP and validated. CVIA is a dynamic analysis of the vessel-bridge interaction during a collision event. It also involves certain generalizations about collision scenarios and other refinements that significantly shorten computation times. CVIA has been validated using data from experimental impact tests on bridge structures. OPTS involves a simplified model of the bridge structure based on the researchers' familiarity with problems of this type. OPTS was verified as accurately predicting pier structural responses relative to corresponding full-bridge structural response predictions.

The researchers conducted a cost-benefit analysis for a selected in-service bridge to demonstrate potential cost differences in sized structural and foundation members, as identified by comparing results from static and dynamic vessel collision analyses. The effects of various impact conditions and geotechnical considerations on impacted bridge pier response were explored. Computation times of full-bridge models and the OPTS models employed in the current study were compared.

This project demonstrates the very practical value of research into algorithms and mathematical methods as FBMP makes available to the working engineer the latest research in practical bridge design software. Better design means more stable and secure transportation structures and greater safety and efficiency.

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For more information, visit http://www.dot.state.fl.us/research-center