Florida Department of Transportation Research

Managing Florida's Fracture Critical Bridges – Phases 1 and 2

May 2016

Project Number
BDV29-977-17

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Current Situation

A survey found that approximately 11% of steel bridges in the U.S. contain members that are "fracture critical." A significant number of these are box girder bridges. "Fracture critical" is a formal designation based on design characteristics, making such bridges subject to regular, detailed, and expensive inspections. However, some bridges have been noted to have cracks in some part of the box girder and yet remain in service with no indication of failure. This suggests that the stability of these bridges is not always linked to fracture critical members and that engineers need a deeper understanding of how these bridges carry loads, possibly changing the formal definition of "fracture critical."

This view of one set of lanes on a Florida bridge shows the twin steel box girders and cross-braces.

Research Objectives

Florida International University researchers examined the possibility of removing twin steel box-girder bridges from the list of fracture critical structures. They studied the behavior of steel twin box-girder bridges and developed a tool to quantify the redundancy level of these bridges in the event that one girder is completely fractured. The effects of cross-frames, both within and between the girders, were also studied.

Project Activities

In the first part of the project, a comprehensive set of experiments was performed on a small-scale twin box girder bridge section. The "small-scale" structure was approximately nine feet wide, 40 feet long, and two feet high, consisting of a reinforced concrete deck supported by two steel box girders. The model was thoroughly instrumented. Investigations were conducted on the intact structure, with specific damage to the girders, under a simulated catastrophic failure, and in ultimate load tests which loaded the structure to failure. Loading was achieved by the use of hydraulic rams. Extensive finite element modeling was conducted to analyze the distribution of loads in the structures and modes of failure in the laboratory model.

The second part of the project involved full-scale testing on a segment of a twin box girder bridge in Ft. Lauderdale. The bridge was prepared and instrumented by the research team. Load distribution in the bridge segment was monitored under loading by the passage of trucks weighing over 30 tons. The main goal of field testing was to calibrate the finite element models and verify the accuracy of the modeling techniques that were used in the redundancy analysis of twin box-girder bridges. Another target was to observe the behavior of an existing two-girder bridge under actual truck loading.

Project Benefits

Based on their findings, the researchers developed a structure analysis methodology that will allow engineers to better understand the behavior of twin steel box girder bridges. More precise classification of bridges will allow for better prioritization of resources and a healthier transportation infrastructure overall.

For more information, please see dot.state.fl.us/research-center