Florida Department of Transportation Research

Redundancy of Twin Steel Box Girder Bridges

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Current Situation

Steel box girder bridges offer many advantages to the bridge designer. Depending on the bridge, steel box girders can offer lower construction costs, reduced construction time, and reduced maintenance costs. However, steel box girders can be subject to fatigue cracking. A significant crack can develop without visible changes in the bridge that would signal the need for immediate inspection. Therefore, it is critical that such bridges have adequate reserve capacity to prevent collapse until a regular inspection can reveal damage to a girder. Increasing the frequency of inspection is undesirable as inspections are time consuming and expensive. Recent research has resulted in design specifications that can ensure additional redundancy using twin steel box girders in bridges with multiple spans.

Box girders are placed during the construction of a bridge.

Research Objectives

Florida International University researchers established a design-phase performance target and safety level for twin steel box girder bridges, outlining a methodology and approach for assessing the redundancy of these bridges and assessing the redundancy of one curved girder bridge using the recommended approach.

Project Activities

The researchers had laid a foundation for this work in a previous project (BDV29-977-17) that investigated inspection protocols for bridges with fracture-critical members. The key issue in this project was to establish the load level which should be set as a design target to assure that redundancy provides a sufficient margin of safety.

A test bridge with a span of 120 feet was used as a model for a reliability analysis. Likely loads were determined from 32 weight-in-motions detectors from which data were collected over a period of four years. These data were used to develop a live load model of the loads the test bridge would likely be subjected to over a two-year period, within which a regular inspection would be conducted. Results from the previous project validated this approach.

The previous project also indicated that concrete deck bending is the dominant failure mode if one of the girders fractures. Combining this result with a line analysis method proposed by University of Texas researchers produced a simplified method of redundancy analysis, thus avoiding the need for finite element analysis for each loading case. A set of reliability indexes was developed based on expected live loads. These indexes can be used to evaluate bridge designs and ensure that the bridge deck and the intact girder can carry the expected loads until the next inspection.

Project Benefits

The design methods developed in this project will help ensure the safety and reliability of twin steel box girder bridges.

For more information, please see www.fdot.gov/research/.