Florida Department of Transportation Research

Straight Steel I-Girder Bridges with Skew Index Approaching 0.3

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BE535

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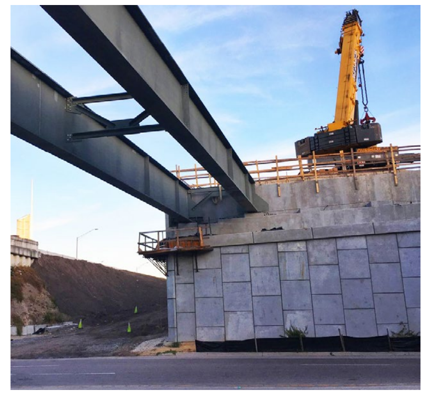
Current Situation

The straight girder bridge is a common bridge type, in which a series of straight steel or concrete girders stretch from an abutment on one side of the gap to an abutment on the other side. For wider gaps, there will be support structures and more girders. In the simplest case, the abutments and supports are all parallel to each other, while girders are parallel to each other and at right angles to the supports and abutments. Many interstate overpasses are examples of this bridge type, carrying a straight stretch of highway over another highway. However, if the abutments are parallel but offset, the bridge must run at an angle (skew angle) to the abutment. This change may seem subtle, but consider the massive weight of the girders, supports, and bridge deck, and you may begin to understand that this simple change in geometry introduces complicated changes in how the mass of the bridge is distributed across the girders and the supports (dead load), especially when traffic is added (live load). Skew bridges must be carefully designed to eliminate strains that can induce cracks in the bridge deck or structural components. Greater skew angles mean greater complexities, requiring more precise calculations than traditional design methods, but few offices will have the expensive computers, software, or expertise to use advanced design tools.



This straight steel I-girder bridge under construction shows key features like the concrete abutment, the I-beams, and a cross frame.

Research Objectives

Researchers at Heath & Lineback Engineers, Inc., used advanced design tools for straight steel I-girder (SSIG) bridges to explore using traditional design methods for higher skew angles.

Project Activities

The researchers selected 26 bridges from the Florida Department of Transportation (FDOT) Bridge Inventory that represented the range of SSIG bridges in Florida. Bridge date were derived from engineering drawings, including bridge geometry, cross frame layout and sizes, girder sizes, and deck specifications. Bridges were divided into five categories based on three factors: skew angle; skew index, which is related to skew angle; and whether girders or abutments were parallel. The skew index of the 26 bridges ranged from 0.15 to 0.47. FDOT allows SSIG bridges with a skew index ≤0.2 to be analyzed with traditional one-dimensional methods, but if the skew index exceeds 0.2, more advanced two- or three dimensional finite element methods are required.

The researchers analyzed each bridge using both traditional and the more advanced methods, focusing on 13 key attributes, such as girder bending moments and girder live load deflections. Results showed that traditional analysis using equal distribution of dead loads to the girders and established AASHTO live load distribution factors provided a fast and sufficient solution for SSIB bridges with a skew index up to 0.45 and skew angle up to 50 degrees with certain qualifications. Recommendations were provided for improved design calculations of girder flange lateral bending stresses and cross frame and diaphragm forces.

Project Benefits

This project expands our understanding of skew bridges and increases the number of bridge designs which can be analyzed using traditional methods, which promises to reduce the time and workload required to design better bridges.

For more information, please see fdot.gov/research