Florida Department of Transportation Research

Straight Steel I-Girder (SSIG) Bridges with Skew Index Approaching 0.3

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Current Situation

About 250 straight steel I-girder (SSIG) bridges were constructed in Florida from the years 2000 to 2014, with over 90% having a skew index of less than 0.3. Prior research has shown that the skew index is a parameter that indicates the degree to which the skew angle may affect girder behaviors, such as moments, shears, reactions, deflections, lateral flange bending, and cross frame loads. Current FDOT design policy would require over one-third of these bridges be designed using a 2D grid or 3D finite element model (FEM) whereas a line girder analysis (LGA) has sufficed for many years. Refined analyses, namely 3D FEM, require expensive software and greater time to develop the model and process the results. Refined analyses are very dependent on a staff knowledgeable in both FEM theory and techniques and the analysis software. The LGA is the simplest and most basic method in the analysis and design of SSIG bridges. To maximize engineering effectiveness, an appropriate analysis must be matched to the bridge structural system.

Continuous-span steel I-girder bridge with skewed support, Spruce Street Interchange, Tampa, Florida

Research Objectives

The objective of this research was to better understand the behavior of SSIG bridges with skew indices up to and slightly above 0.3 and to determine when an LGA will yield girder behaviors that are very similar to those obtained from a 3D FEM.

Project Activities

The researchers selected 26 out of 57 bridges, representing the range of SSIG bridges in Florida. Bridge data were derived from engineering drawings, including bridge geometry, cross frame layout and sizes, girder sizes, and concrete deck properties. Bridge characteristics considered included the bridge articulation (simple- or continuous-span construction), skew index, skew angle, cross frame type and layout, span lengths, and framing widths. For the selected 26 bridges; the skew index ranged from 0.15 to 0.47, and the skew angle ranged from 10 to 59 degrees.

The researchers analyzed each bridge using both LGA and the more advanced 3D FEM, focusing on 13 key behaviors, including girder bending moments, shears, reactions, deflections, lateral flange bending, and cross frame loads. Results showed that an LGA using equal distribution of dead loads to the girders and the established AASHTO live load distribution factors provided a fast and sufficient solution for SSIG bridges with a skew index up to 0.45 and skew angle up to 50 degrees, with certain other attributes. Specifically, three cases were developed based on skew index, skew angle, and cross frame arrangement. In addition, recommendations provided improved estimates of girder flange lateral bending stresses and cross frame forces.

Project Benefits

This project expands our understanding of SSIG bridges and increases the number of bridge designs which can be analyzed using LGA, which will reduce the time and workload required to design this type of bridge.

For more information, please see fdot.gov/research