Florida Department of Transportation Research

Distribution Factors for Construction Loads and Girder Capacity Equations

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Current Situation

At its most basic, the construction of girder bridges requires the placement of a support structure, then girders, then a concrete deck. During the process of placing the girders, they are secured at first only by their weight. Later, cross-bracing will be added. Despite the girders' weight, before cross-bracing, they are vulnerable to high winds. Planning for this vulnerability is part of the design process, and it requires a detailed understanding of the internal and external forces that can affect bridge girders during construction.

Research Objectives

This project focused on the use of Florida I-beams (FIBs) in bridge construction. University of Florida researchers used analytical models and finite element analysis to update equations used in the design of bridges using FIBs. They were particularly interested in thermally induced sweep, a sagging effect caused when a girder expands and lengthens in the Florida sun. If not properly planned for, sweep can increase a girder's vulnerabilities.

While under construction, bridge girders are cross-braced for stability.

Project Activities

In the first task of the project, the researchers used analytical models of FIBs to update capacity equations for wind load and gravity load they had developed in a previous project (FDOT research project BDK75-977-33). Based on a literature review, the researchers revised the definition of lateral girder sweep to include thermal sweep and to expand the extent of sweep considered in the capacity equations.

Using the revised definition of sweep, analysis procedures and finite element models of unanchored FIB bridge girders with wind loads were used to revise the equation for this condition developed in the previous study. Also, the revised definition of sweep also led to updating a fundamental 'baseline' equation in the analysis, the buckling capacity of an unanchored two-girder strut-braced system with no wind loading. A parametric study was subsequently conducted to ensure that the equation for the capacity of a multi-girder system with moment-resisting braces remained conservative when compared to the corresponding capacities computed by finite element analysis.

The methods of the project were then extended to a wide range of typical bridge system configurations. Empirical distribution factor equations were developed through a large-scale parametric study that considered different Florida-I Beam cross-sections, span lengths, girder spacing, deck overhang widths, skew angles, number of girders, number of braces, and bracing configurations (K-brace and X-brace) to quantify shear and moment distribution factor data. The resulting factors allowed development of empirical construction stage distribution factor equations at multiple levels of design conservatism.

Project Benefits

Improved bridge design methods help assure more durable and safe structures in the Florida highway system.

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