Live Load Distribution Factors for Grid Reinforced Concrete Decks

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Background

Current AASHTO LRFD Bridge Design Specifications (2nd Edition, 1998) include a more accurate method for distributing live load to longitudinal superstructure members (stringers and girders) than previous methods. These improved methods are based upon National Cooperative Highway Research Program (NCHRP) Project 12-26, conducted by lmbsen & Associates, Inc. The new code also provides a much clearer treatment of this design issue regarding steel grid flooring systems, since the current Standard Specifications, 16th Edition, provide for different live load distribution factors for grids based solely on deck thickness (either < or > 4” deep) and make no distinction as to whether the deck is an open grid, or a grid reinforced concrete deck.

Live load distribution factors included in the LRFD code make the distinction between the two types of grid deck quite clear. Filled and Partially Filled Grids are properly treated by the same Code provisions that are used for rebar slab concrete bridge decks, whereas Open Grids occupy a completely separate category.

Those new factors appear in the LRFD Code in the following tables:

Table 4.6.2.2.2b-1, page 4-30: Distribution of Live Loads per Lane for Moment in Interior Beams

Table 4.6.2.2.2d-1, page 4-33: Distribution of Live Loads per Lane for Moment in Exterior Beams

Table 4.6.2.2.3a-1, page 4-36: Distribution of Live Loads per Lane for Shear in Interior Beams

Table 4.6.2.2.3b-1, page 4-38: Distribution of Live Loads per Lane for Shear in Exterior Beams

The formulas in those tables which apply to Filled or Partially Filled Grid contain a variable t_S (depth of concrete slab) which represents the overall deck thickness, including a structural overfill or properly bonded rigid overlay, if present.

Field Measurements of Distribution Factors

The applicability of use of the new formula was first demonstrated in the field by tests conducted on the North Main Street Bridge, Akron, Ohio, which is owned and maintained

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W. Va. Dept. of Highways supplied test vehicles used to gather data for calculating distribution factors.

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by Summit County. Testing is described in a paper entitled **"EFFECTIVE FLANGE WIDTH AND LIVE LOAD DISTRIBUTION FACTOR FOR CONCRETE FILLED STEEL GRID DECK"**, originally presented at the 1994 International Bridge Conference in Pittsburgh.

On the North Main Street Bridge, where a **4-1/4' Fully Filled Grid** with a 1-1/4" integral overfill rests on stringers spaced 6-4-1/2" c/c, the measured live load moment on interior beams is smaller than S/9.5, compared to S/6 as provided for in the current AASHTO Standard Specifications. The measured distribution factor is also about 20% lower than the wheel load distribution factor recommended by the LRFD Code for a rebar deck of equal thickness.

Field tests were also conducted to obtain results on **Partially Filled Grid Decks.** Based upon results from tests conducted on the Upper Buckeye Bridge in Doddridge County, West Virginia, it was demonstrated that the new formulas were applicable to Partially Filled systems as well, with t_s equal to **overall deck thickness,** again including overfill. On this project, a three span bridge with girders spaced 8.25' was rehabilitated using a Partially Filled Grid weighing approximately 70#/SF. The title of the document describing these tests is **"FULL SCALE TEST OF HALF DEPTH GRID ON UPPER BUCKEYE BRIDGE TO DETERMINE EFFECTIVE FLANGE WIDTH, LIVE LOAD DISTRIBUTION, AND GRID DECK STRESSES"**, which was published by the BGFMA in May, 1996.

When using the LRFD Code, established live load distribution factors, as contained in the referenced tables, should be used. Based upon the data from both test programs, it is recommended that, when using AASHTO's Standard Specifications, that nothing less than S/5.5 (multi-lane) be used for a **Filled or Partially Filled Grid.**

Rehabilitation of a multi-girder bridge in Doddridge County, W. Va. provided an opportunity to conduct field tests

This reduction in moment can be used to reduce beam sizes on new structures, or to allow for an increased capacity on existing stringers or girders. This benefit is further enhanced by the weight savings that is offered by grid reinforced concrete decks.

Summary

A better understanding of grid reinforced concrete bridge deck behavior and its interaction with supporting members, gained from both lab and field testing, allows for the use of more realistic design rules regarding live load distribution factors. These rules are contained in the LRFD Code, and can be used to improve the first cost economy of structures built or rehabilitated with Fully and Partially Filled Grid Reinforced Concrete Bridge Decks.

References

AASHTO LRFD Bridge Design Specifications, 2nd Edition, 1998

"Effective Flange Width and Live Load Distribution Factor for Concrete Filled Steel Grid Deck", BC Paper 94-26, Ahmadi, Ahmad, Ph.D., PE

"Full Scale Test of Half Depth Grid on Upper Buckeye Bridge to Determine Effective Flange Width, Live Load Distribution and Grid Deck Stresses", BGFMA Test Report, Ahmadi, Ahmad, Ph.D., PE, May 1996

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