Wisconsin Highway Research Program
Structures Technical Oversight Committee
Request for Proposals for

Design and Performance of Highly Skewed Deck Girder Bridges

Questions regarding the content of this RFP are due no later than
4:30 PM (CST) on December 10, 2014

Responses to questions will be posted to the WisDOT Research and Library website
http://wisdotresearch.wi.gov/rfps-and-proposals by
4:30 PM (CST) by December 17, 2014

Proposers must submit a PDF version of their proposal by
4:30 PM (CST) by January 23, 2015
to this secure email address: upload.FY16_RF.5lvu691ai6@u.box.com
Submitter will receive an emailed auto-confirmation of proposal receipt.

Proposers will be notified by May 1, 2015

For further information regarding this RFP contact:
Angela Pakes Ahlman
email: apakes@sustainability.wisc.edu

Researcher Questions on RFP

Please refer all questions on this RFP to the WHRP Technical Director, Angela Pakes Ahlman by the aforementioned due date. Questions must be in writing. No response will be provided to questions received after the due date.

Researcher Proposal Preparation Guidelines

WHRP Proposal Guidelines are available on the WisDOT Research and Library website http://wisdotresearch.wi.gov/rfps-and-proposals. Please refer to these instructions in preparation of your response.

Wisconsin Highway Research Program
Structures Technical Oversight Committee
Request for Proposals for

Design and Performance of Highly Skewed Deck Girder Bridges

I. Background and Problem Statement

Given the need of roadway geometric engineers to align roadways and bridges with features within their projects, it is occasionally unavoidable to limit the skew of some bridges. Wisconsin DOT has ongoing concerns with the design, construction, and performance of bridges with a high degree of skew (defined as skews greater than 20 degrees). The implications of highly skewed bridges are curing and temperature induced stresses as well as live load induced racking and uplift at acute corners. These induced forces affect the decks, end diaphragms, wing walls, expansion joints, and bearings and are difficult to quantify with conventional line girder analytical models. Bridge designers have limited clear guidance on what are the practical limits of conventional line girder analysis methods in relationship to skew of the bridge. In addition, there are needs to address the unique stresses that develop in skewed bridges in the acute deck corners, end diaphragms, expansion joints, bearings, and substructure units related to the tendency for racking motion.

Recently, two bridges were designed over the Hank Aaron State Trail in the Zoo interchange corridor with highly skewed substructure that required a number of design assumptions on performance related to skew as well as innovative unconventional combinations of expansions and fixed bearings at substructure units. These bridges may serve as ideal subjects for instrumentation and validation of design methodology and construction features.

There is clearly the need to research the effects of highly skewed deck girder bridges to provide designers better guidance with how to define, analyze, and accommodate:

- Skewed bridges, (20 – 60 degrees or more).
- Racking forces and displacements
- Forces and reinforcement in critical deck locations and substructure units
- End diaphragm forces
- Expansion joint movements
- Bearing forces, bearing arrangements and combinations on substructures
- Correlation of design methodology to actual in-service performance

Ultimately, a better understanding of the actual forces developed in highly skewed bridges as well as an understanding of the limits of conventional line girder models of highly skewed bridges will lead to better performing bridges.

II. Objectives

The objective of this research is to develop guidelines for designers related to the design of highly skewed bridges. These guidelines will ultimately be published in the WisDOT Bridge Manual and serve designers in understanding and designing highly skewed and curved bridges that have improved performance. These objectives will be achieved by:

A. Identifying the locations on deck girder bridges that are vulnerable to skew and temperature related deformations and stresses.
B. Defining the forces that develop in the acute corners of bridge decks and substructure units and how reinforcing and other details should be modified to minimize potential of cracking.
C. Defining the practical limit of skew angle that a conventional line girder analytical model should be applied before a more complex method of analysis is adopted.
D. Examine the theoretical and actual movement of expansion joints on highly skewed bridges.
E. Defining the forces that are transmitted to expansion and fixed bearings as a result of high skew angles and any modification needed to standard details to better accommodate these forces.
F. Examination and validation of the innovative practice of placing both expansion and fixed bearings on highly skewed substructure units (piers) to provide adequate relief to the development of racking forces and motion of the superstructure.
G. In field measurement of actual performance of highly skewed bridges including the spring/summer 2015 constructions of the B-40-870, EB IH-94 over HAST.

III. Scope of Work

A. Research and document the current practices, guidance, and related information related to Highly Skewed deck girder bridges.
    1. Current WisDOT Design Policy, Standards, Practice, and Guidance.
    2. Literature Search including other State DOTs.
B. Review of WisDOT in-service highly skewed Deck Girder Bridges to identify performance issues.
C. Analytic Modeling (Conventional Line Girder, 2-D Grid Analysis, and Complex Method (FEM)).
D. Instrumentation and monitoring of forces and movements in actual in-service bridge for 2016 Construction.
E. Develop recommendations and guidance in format consistent with WisDOT Bridge Manual.
F. Work will be conducted with project oversight by the WisDOT Bureau of Structures and WHRP Structures TOC.

IV. Specific Results, Findings, Tools, etc. (Deliverables)

A. Reporting Requirements: 7 hard copies and electronic files must be delivered to WHRP by the contract end date. This includes the report, special provisions, and structural details.
    - Please refer to the Implementation section (VI.) for further details.

B. Presentation Requirements: All projects require the PI to give a closeout presentation to the TOC after submittal of the draft final report.

V. Budget and Schedule

A. Project Budget **shall not exceed $150,000**. Matching funds will not be considered in the proposal evaluation process.

B. Proposed project duration is **24 months.**

- The researcher is expected to submit the draft report with quality technical writing and proper grammar. It is acceptable to include a technical editor on the research team to ensure these requirements are met.
- Deadline for submittal of draft final report is three months prior to contract end date to allow for report review activities.
- Deadline for research close out presentation is 4-6 weeks prior to contract end date.
- Deadline for submittal of the Final Report is the contract end date.

VI. Implementation

Successful implementation of this research will be achieved through the development of the following items:

- Development of guidance to designers related to the unique forces induced in highly skewed deck girder bridge decks, end diaphragms, wing walls, bearings, and substructures. This guidance will need to be in a format consistent with inclusion in the WisDOT Bridge Design Manual.
- Guidance on the practical limits of conventional line girder models for use in highly skewed bridges. This guidance needs to outline the specific short comings of the conventional approach and offer recommendations for more appropriate methods of highly skewed bridges.
- Field evaluation including inspection and instrumentation the IH-94 bridge over HAST that provides validation of the innovative bearing design, stresses in select locations of deck, and movement in expansion joints and bearings.