Wisconsin Department of Transportation

Wisconsin Highway Research Program

Request for Proposal

Evaluation of Concrete Pavement Buckling in Wisconsin

Questions submitted to research@dot.wi.gov regarding the content of this RFP are due by **4:30 PM (CST) on January 4, 2019**.

Responses to questions will be posted to the WisDOT Research and Library website (https://wisconsindot.gov/Pages/about-wisdot/research/researchers.aspx) by **4:30 PM (CST) on January 11, 2019**.

Proposers must submit a PDF version of their proposal to research@dot.wi.gov by **4:30 PM (CST) on February 6, 2019.**

Proposers will be notified of the proposal review decision by **May 1, 2019**.

This RFP is posted on the WisDOT Research and Library website (https://wisconsindot.gov/Pages/about-wisdot/research/researchers.aspx). For more information, contact the WisDOT Research Program at research@dot.wi.gov.

Wisconsin Highway Research Program (WHRP)
Request for Proposals (RFP)
Rigid Pavement Technical Oversight Committee (TOC)

Evaluation of Concrete Pavement Buckling in Wisconsin

I. Background and Problem Statement

Buckling (i.e., blowup) in concrete pavement is caused by axial compression forces induced into the pavement by a rise in temperature and moisture[1]. It is a localized upward slab movement leading to the shattering of joints and cracks. It typically occurs in hot weather, usually at transverse joints that are not properly designed to allow for slab expansion. The insufficient joint widths are usually caused by the infiltration of incompressible material into the joint space and cracks. As the thermal expansion coefficient is dependent on moisture, moisture content is also an important factor for forensic studies of buckling. Because buckling incidents on concrete pavement immediately impact traffic flow and public safety, it requires urgent, costly, and time-consuming emergency repairs (i.e., full-depth repair) with full or partial lane closures. In 2018, there were 73 cases of buckling events in the State of Wisconsin. An unusually high number of buckling events have occurred in only a few locations. For example, there were multiple buckling events on USH-10 and I-39 near Stevens Point and on STH 29 just North of Eau Claire in 2017 and 2018. Buckling also occurred in newer concrete pavements as well.

This study will investigate past buckling incidents and disclose the mechanism of buckling in Wisconsin. The researchers will thoroughly inspect roadway conditions adjacent to the buckling, including historical pavement surface conditions, joint condition, roadway geometry, and surface and subsurface drainage systems. The researchers will take pavement cores and investigate air voids, coefficient of thermal expansion and joint width and performance, and visit incident sites to reveal key mechanisms and controlling parameters behind the buckling incidents. This research will also critically review concrete pavement mixture design practices and pavement construction methodologies to recommend changes with the aim of reducing future buckling events.

II. Research Objectives

The objectives of this study are to (a) investigate buckling of concrete pavements in Wisconsin roadways, (b) reveal the key mechanisms for buckling in Wisconsin with forensic studies, and (c) identify innovative methods to mitigate buckling incidents and associated costs.

III. Scope of Work

A. Conduct a comprehensive literature review and assessment of pavement buckling incidents, possible causes of buckling, and applicable mitigation methods for buckled pavements.

B. Consult various state DOTs, the FHWA, Canadian Ministries of Transportation, and industries.

[1] Kerr, A.D., Shade, P.J., and Park, F., 1984. "Analysis of Concrete Pavement Blowups." *Acta Mech*, Vol. 52, pp. 201-224.

C. Identify pavement sections where buckling has occurred in Wisconsin and conduct field investigations to reveal key mechanisms and controlling parameters. Field visits should include the following tasks:
    1. Assessment of pavement surface and subsurface conditions (i.e., distresses on both surface and joints adjacent to where the buckling occurred) that includes joint performance, joint spacing, expansion joint width, and dowel bar alignment and base layer performance.
    2. Evaluation of geometrical parameters, including horizontal alignment and sag and/or crest vertical.
    3. Evaluation of other structures affecting pavement sections, such as proximity to intersections, bridges, railway crossings and other fixed structures.
    4. Observation of drainage systems including: base layer, pipes and culverts beneath the pavement.
    5. Collection of weather data associated with the buckling: temperatures (including sudden temperature changes before buckling events), humidity levels, months of year, etc.
    6. Provide historical pavement survey data as needed.
D. Obtain concrete pavement core samples adjacent to the buckling sites identifying mechanical properties of the pavement.
E. Design and conduct a laboratory testing program for pavement cores. Investigate the buckling phenomenon and determine methods to mitigate future buckling incidents. Use the cores from the sample extracted from the buckling incident if they are available (see Section V.B below). The laboratory testing program should focus on finding the controlling parameters for buckling incidents in typical Wisconsin environments.
F. Assess effective techniques for mitigating buckling incidents and provide guidelines on what changes WisDOT needs to make to concrete pavement mixes and construction practices (e.g., width of expansion joints, panel width, etc.) to improve performance.
G. Develop recommendations and guidelines to mitigate buckling in a format consistent with Wisconsin Standard Specifications, Construction and Material Manual (CMM), Facility Development Manual (FDM), and Highway Maintenance Manual and develop associated presentation materials for WisDOT practitioners.

IV. Required Testing

A. Field inspection
    1. Thorough forensic investigation of the pavement (if samples are available) and adjacent pavement where the buckling occurred. (For multi-lane facility, the adjacent lane could be included in the field inspection.)
    2. Optional non-destructive testing. The research team can propose methods and/or technology for non-destructive testing that are deemed to be most effective in accomplishing the project objectives.
B. Coring samples
C. Coring to evaluate the extent and nature of internal concrete distresses that are associated with the buckling incidents. Care should be taken to extract cores in an intact condition whenever possible. These cores need to be made available for review by WisDOT staff. Photographic documentation of all cores and core holes should also be provided.

V. WisDOT/TOC Contribution

WisDOT will provide the following support through the Project Oversight Committee (POC) and WisDOT Regional Engineers:

A. Work will be conducted with project oversight by the WHRP Rigid Technical Oversight Committee (TOC). The TOC members will appoint a Project Oversight Committee (POC) to support the successful completion of the project.

B. WisDOT may preserve samples of pavement extracted from the buckling location if buckling samples can be collected in 2019. If available, these samples will be provided to the researcher for further investigation.

C. The research team will not assume the availability of WisDOT staff or equipment in the proposal. If WisDOT or another entity donates equipment or staff time, a letter of commitment must be included in the proposal.

D. WisDOT staff/TOC members can be expected to contribute a maximum of 40 hours over the duration of the project. The research team will consult with POC members in the selection of project sites.

E. If field work on or around in-service facilities is anticipated to conduct this research then the researcher shall specify in the proposal the nature and extent of traffic control that will be required for this project including: traffic flagging, sign-age, barricades, etc., as well as the duration needed (hours/day/location). There also needs to be a discussion in the proposal of the specific traffic control support that is being requested from WisDOT. The researcher will need to coordinate the location(s) of the project fieldwork with the POC chair, WisDOT regional personnel and possibly the county personnel. The researcher should make accommodations in their proposal budget for traffic control and should not assume WisDOT will fund traffic control expenses.

VI. Required Travel

This project will require travel to the project sites across Wisconsin for documentation, measurement, and information collection. It is expected the PI will deliver the final presentation in-person in Madison, Wisconsin.

VII. Deliverables

A. Reporting Requirements: An electronic copy of the final report delivered to WisDOT by the contract end date. This includes the report, special provisions, and pavement details. Please refer to the Implementation section for further details.

B. Presentation Requirements: The PI is required to give an in-person Close-Out presentation to the TOC.

C. Policy recommendations for Construction Manual, draft Specification and Special Provisions (SPV) related to implementation of buckling mitigation for concrete pavement.

VIII. Budget and Schedule

A. Project Budget shall not exceed **$200,000.**

B. B. Proposed project duration is **24 months** starting around **October 1, 2019.**

C. Deadline for submittal of Before Close-Out presentation (BCOP) report is three months before the contract end date to allow for report review activities.

D. Deadline for research Close-Out presentation is six to eight weeks before the contract end date.

E. Deadline for submittal of the publication-ready version of the After Close-Out Presentation (ACOP) report is the contract end date.

IX. Implementation

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

A. Final report detailing the results of the research project and following the report preparation instructions: Researcher Report Preparation.

B. The final report should be a maximum of 50 pages ***(***plus supporting appendices***)*** and be as concise as possible.

C. The research team should format the report such that significant findings are provided at the beginning (e.g., in an extended executive summary).

D. Clear and concise commentary on the results of the field investigation of the buckling locations and result of laboratory testing to reveal the key mechanism of buckling and effectiveness of buckling mitigation strategies to reduce future buckling in Wisconsin. This will include documentation of other DOTs' past practices applying buckling mitigation methods and their performance.

E. Recommendations on practical and effective approaches to mitigate buckling for WisDOT pavement design, construction, and maintenance process.

F. Develop key points describing how to update WisDOT Standard Specification, Construction Manuals chapters, and Highway Maintenance Manual related to concrete pavement.

G. Draft Special Provisions (SPV) for concrete pavement that would be consistent with the format and nature of the current specifications if necessary. The Wisconsin DOT Standard Specifications should be used as a starting point for modification to Special Provisions as appropriate.