Wisconsin Department of Transportation
Wisconsin Highway Research Program

Request for Proposal

Roadway Concrete Barrier Design and Performance – Material Durability Issue

Questions submitted to research@dot.wi.gov regarding the Content of this RFP are due no later than 4:30 PM (CST) on December 12, 2017

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 19, 2017

Researchers must submit a PDF version of their proposal by 4:30 PM (CST) by January 26, 2018 to: research@dot.wi.gov

Researchers will be notified of the proposal review decision by May 1, 2018

For more information regarding this RFP contact the WisDOT Research Program at: research@dot.wi.gov. This RFP is posted to the Internet at: http://wisdotresearch.wi.gov/rfps-and-proposals

Wisconsin Highway Research Program
Request for Proposals
Rigid Pavement Technical Oversight Committee

Roadway Concrete Barrier Design and Performance – Material Durability Issue

I. Background and Problem Statement

Concrete barriers are installed to shield the traveling public from hazardous objects. They can serve to prevent errant vehicles from departing the travel way and to minimize vehicle damages from crossover collisions. Wisconsin Department of Transportation (WisDOT) has been building single-slope concrete barrier on highway projects since 2011. It requires lower maintenance cost, has better crash performance and it is more flexible with overlay projects. As the older barriers built using this design have been in service for several years, some of the barriers have shown distresses that that may influence long term barrier durability and potentially the safety of the barrier. A damaged concrete barrier typically requires lane closure, which leads congestions and creates more expensive user costs in addition to the repair cost. There are several distresses observed are listed below (the list is not all inclusive).

- Hairline cracking patterns
- Transverse and longitudinal cracking
- Toe of barrier breaking off

There are various possible causes for these distresses and many of them could cause long term maintenance issues. There is a potential for some of the distresses to influence the safety performance of the concrete barrier. The potential examples of how these distresses could cause long term safety issues are listed below (the list is not all inclusive).

- Propagated distresses expose the steel bar or bolt in the concrete barrier and cause corrosion which requires patching.
- Corrosion of steel bars or bolts can cause the defects and reduce the capacity of the barrier (FHWA 2014[1])
- Concrete cracks or pop-outs could cause excessive deceleration of vehicle's occupants, vehicle roll-over; increasing the chance of a fatality
- Fragments of the barrier can become hazardous projectiles during a crash

In-depth investigation should be conducted to reveal the source of the distresses and prevent the propagation of the distresses. Ultimately methods to minimize or eliminate the risk of potential distress should be developed. Using research dollars on this topic will reduce long-term maintenance cost and likely improve the safety of the traveling public

II. Goals and Objectives

The goal of this project is to investigate concrete distresses showing in single-slope concrete barriers on highway projects and make recommendations to update our current WisDOT barrier practices such as concrete barrier design, construction method, and maintenance procedure to achieve the long-term performance of them. This study focuses on investigating the material cracking and suggesting strategies to prevent them. The crash performance of the barrier is not included in this study.

[1] FWHA. (2014). Nondestructive Inspection Protocol for Reinforced Concrete Barriers (No. FHWA-HRT-14-071).

The objectives of this project are:

- Investigate the concrete barrier design and the construction method that have been commonly applied in US.
- Assess the barrier design and construction method and inspection procedure used in Wisconsin.
- Evaluate the material performance of the currently installed single-slope concrete barriers by performing field study. This includes:
    - Catalog barrier distress types and their frequency
    - Associate the barrier cracks with the particular barrier design used.
    - Review construction project records and interview project staff for documentation on:
        - Barrier materials
        - Barrier Contractor
        - Construction methods used
        - Issues during construction
- Provide an interim report on the results of the field study to the committee. Address to the following questions.
    - What is overall frequency of different distress type and is there any patterns in the types of cracks?
    - What distresses can be solved by the current state of knowledge?
    - What distress types need field sampling to determine a solution?
    - What are is prioritization of distresses for additional research within this project?
- Collect field samples, conduct lab testing and assess the results of testing.
- Recommend improvements in design, construction, and materials used in concrete barrier construction.
- Make recommendations on the material and methods used to improve maintenance activities to the concrete barrier.

III. Scope of Work

Task 1: Synthesis of Current Practices and Research

Conduct a comprehensive literature review that summarizes the state-of-the art of concrete barrier design and construction at various state DOTs, FHWA, industries and manufacturers. This literature review should at a minimum include:

- Summary of other states current specifications, design and inspection manual.
- Comparison of other state specifications to current WisDOT's practice regarding concrete barrier design and construction.

Task 2: Conduct Initial Field Investigation of Concrete Barrier in Wisconsin

The Project Oversight Committee (POC) will provide project data of concrete barrier installed in Wisconsin to the researcher(s). After consultation with POC members, researchers shall identify barriers that can be investigated for this study.

Based on the selected barriers, the researcher(s) will investigate the concrete barriers for initial cataloging of barrier distresses, collection of construction project records, and project

staff interviews. Data collected should focus on long term durability issues. Researchers will likely need to conduct a visual survey and measurement of the barriers. Phone, in-person or other methods may be used to conduct interviews.

Task 3: Produce Interim Report and Have Interim Meeting
Provide an interim report of data collected and analyzed in Task 2 to POC. Address the following issues:

- Overall frequency of different distress type
- Any patterns in the types of distress
- The distress types that can be solved by the current state of knowledge
- The distress types that need field sampling to determine a solution
- Suggested prioritization of distresses types for additional research within this project

After producing interim report, researcher(s) conduct interim meeting with POC to review the interim report. Meeting will review researcher's recommendation on what distress types need additional field research. POC may change what distress types need additional research.

Task 4: Develop Sampling Plan for Distress Types and Conduct the Laboratory Testing
This task includes developing sampling plan consulting with POC members and conduct the testing after POC's approval. The plan should address the locations to be sampled, tests to be run, and the schedule of when sampling is to take place.

Any materials testing will use standardized test methods (ASTM/AASHTO) or tests that have yet to be standardized, but are accepted as current practice in the concrete community as agreed upon by the POC. See *IV. Required Testing* below for details.

Task 5: Analysis Results of Field and Laboratory Tests
This task includes documenting the analysis results from field and laboratory tests.

- Report is to summarize all data collected from previous listed tasks.
- Report is to emphasize how to improve the durability of concrete barriers. design, construction methods, inspection methods and materials.
- Report is to provide recommendations on how to treat existing concrete barriers for common distresses.
- Reports recommendations for improvements should not violate crashworthiness of the barrier.
- Reports is to estimate the life cycle cost savings with following the recommendation suggested by the researcher(s).

Task 6: Project Deliverables

- Draft Final Report: The researcher is responsible for submitting a draft final report to the TOC three months before the end date of the project contract.
- Project Closeout Presentation: The researcher will present findings and recommendations to the TOC. The TOC will supply/document any comments or concerns regarding the final product of the research.
- Final Report: The researcher is expected to address or incorporate any TOC comments prior to delivery of the final report in Wisconsin Highway Research Program (WHRP) format.

IV. Required Testing

a) Non-destructive testing: Selected non-destructive testing will be used on a broader scale on selected test segments of concrete barrier.
   - For evaluation of the extent and nature of internal concrete cracking, honeycombing or other distress in areas of barrier where cracking or other distress is visually apparent at the surface
   - To identify location, extent and nature of internal concrete distress in areas of barrier where no distress is visually apparent at the surface

   The researcher shall propose the method or type(s) of technology for this NDT that they feel will be most effectively accomplish the project objectives.

b) Field inspection and coring: Coring will be used to evaluate the extent and nature of internal concrete distress that is associated with visually apparent surface distress, and to validate the nature and extent of concrete distress identified by NDT methods. Care should be taken to extract cores in intact condition whenever possible for subsequent viewing by WisDOT staff. Photographic documentation of all cores and core holes should also be provided. It may be necessary to wet saw the cores in half, or otherwise as needed to completely evaluate the extent and nature of the concrete distress.

V. WisDOT/TOC Contribution

a) Expected level by staff/TOC members: Maximum of 40 hours. Project Oversight Committee (POC) members will consult with the researcher(s) in the selection of the projects and concrete barrier to be sampled.
b) WisDOT Equipment: The researcher(s) will not assume the availability of WisDOT equipment in the proposal. If equipment is donated by WisDOT or another entity, a letter of commitment must be included in the proposal.
c) It is not anticipated that any WisDOT equipment will be needed as part of this study.
d) If field work on or around in-service facilities is anticipated by the researcher, the proposal will need to discuss the nature and extent of needed traffic control and support assistance that will be requested from WisDOT. The researcher will need to closely coordinate with WisDOT regional personnel and possibly the county personnel where project fieldwork is being conducted. For WisDOT planning purposes, the Principal Investigator shall specify in his or her proposal, as practical, what specific traffic control will be required for this project, such as traffic flagging, signage, barricades, etc., as well as the duration needed (hours/day/location). It should not be assumed that WisDOT would fund the traffic control apart from the research project budget.

VI. Required Travel

This project will require travel for:

- A meeting to finalize the work plan with the TOC, and statewide job site visits to sample concrete assess pavement performance in Task2
- Field inspection and coring collection as part of the activities in Task 3.
- A closeout presentation (COP) in Madison, WI to summarize the activities, results, analysis and recommendations completed during the development of the project.

VII. Deliverables

a) Submittal and reporting of progress as required by the WHRP and WisDOT

b) Presentation Requirements. All projects require the Principal Investigator to give an in-person closeout presentation after submittal of the draft final report.
c) Reporting Requirements. Six (6) hard copies and an electronic copy of the final report delivered to WisDOT by the contract end date.

VIII. Schedule and Budget

a) Proposed Project Duration is **24 months** starting around **October 1, 2019**.
   i. Deadline for submittal of draft final report is three months prior to contract end date to allow report review activities.
   ii. Deadline for research closeout presentation is 4-6 weeks prior to contract end date.
   iii. Deadline for submittal of final report is the contract end date.
b) Project Budget shall not exceed **$150,000.**
c) The researcher is expected to submit the draft final report with quality technical writing and proper English grammar. It is acceptable to include a technical editor on the research team to ensure these requirements are met.

IX. Implementation

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

a) This study will recommend changes to existing concrete barrier design and construction method/specifications and recommendations for use of new method, if any, for the future.
b) This study will quantify the life cycle cost savings expected by following the recommendations of the proposed design and construction method.
c) This study will recommend the future inspection method and frequency so the concrete barrier can perform during expected service life.