Wisconsin Department of Transportation
Wisconsin Highway Research Program

Request for Proposal

Evaluating the Impact of Anti-Icing Solutions on Concrete Durability

Questions submitted to research@dot.wi.gov regarding the content of this RFP are due no later than 4:30 PM (CST) on January 3, 2020

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) by January 11, 2020

Researchers must submit a PDF version of their proposal by 4:30 PM (CST) by February 3, 2020 to: research@dot.wi.gov.

Proposal Preparation Guidelines can be found at: Proposal Preparation Guidelines

Proposers will be notified by May 1, 2020

For more information regarding this RFP contact the WisDOT Research Program at: research@dot.wi.gov.

This RFP has been posted to the Internet at: https://wisconsindot.gov/Pages/about-wisdot/research/researchers.aspx

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

Evaluating the Impact of Anti-Icing Solutions on Concrete Durability

I. Background and Problem Statement

Roadway anti-icing operations use liquid brine and/or other chemicals in liquid form before the snow event to prevent the formation of bonded snow and ice and facilitate their removal. The Wisconsin Department of Transportation (WisDOT) has in recent years increased the use of anti-icing agents in liquid form (anti-icing solution) including sodium chloride, calcium chloride, magnesium chloride and some agricultural byproducts such as beet juice for winter maintenance to reduce costs and improve driving safety[1]. However, there are concerns that the direct application of anti-icing solutions to dry concrete pavement surface and bridge deck prior to a snow event may result in much higher anti-icing agent penetration than the traditional method of applying rock salt to a wet, saturated concrete surface. The direct application of anti-icing solutions may have significant long-term impacts on concrete durability due to the rapid ingress of the anti-icing solution. A survey of winter operation managers in counties and major cities in Wisconsin indicated that these managers have observed accelerated deterioration of concrete near joints and bridge decks with the increased use of anti-icing solutions[1].

Although the adverse impacts of deicers to concrete are commonly recognized, there is limited information available on the impact of anti-icing solution on concrete durability, methods for reducing these impacts, and how impacts relate to the application rates (specifically on dry surfaces). With the increasing use of anti-icing solutions in Wisconsin there is a need to understand and quantify the impact on concrete durability and protect concrete pavements and bridge deck from the physical and chemical impact of anti-icing solutions without compromising safe traffic operations.

II. Objectives

The goal of this study is to quantify the impacts of applying anti-icing solutions that are commonly used in Wisconsin and identify mitigation methods to reduce the long-term impacts without compromising safety. The objectives are to: Identify the commonly applied anti-icing solutions in Wisconsin, evaluate their application rates, and frequency of application.

A. Quantify the impact of applied anti-icing solutions on dry concrete surfaces in Wisconsin.

B. Recommend anti-icing solutions and their application practices and maintenance practices that would reduce the adverse impacts on long-term concrete pavement and bridge deck durability as a part of winter management of Wisconsin roads.

[1] Xiao D., Owusu-Ababio, S., and Schmitt R., 2018. “Evaluation of the Effects of Deicers on Concrete Durability.” WisDOT Report 0092-17-03, Wisconsin Highway Research Program, Madison, WI.

III. Scope of Work

Task 1: Literature Review

Summarize information available from various state highway agencies, industries, and manufacturers related to (1) current liquid anti-icing practices, (2) the impact of liquid anti-icing chemicals on concrete durability, and (3) the application and effectiveness of methods to reduce the detrimental impact of anti-icing solutions. TOC members will provide previous research results published by WHRP to assist with identifying commonly applied anti-icing agents in Wisconsin.

Task 2: Experimental Testing – Penetration rate

Design and conduct laboratory experiments that would provide insight into the penetration rate and impact of anti-icing solutions on concrete durability. Laboratory experiments will test the hypothesis that anti-icing solutions can readily penetrate concrete and lead to more damage than traditional dry deicer materials. Various anti-icing agents and their solutions that are commonly applied in Wisconsin must be included in this task and the various ambient/pavement temperatures. Also, mechanical/environmental conditions should reflect typical pre-snow events and winter conditions in Wisconsin.

Task 3: Experimental Testing – Anti-icing Application

Evaluate the current use of liquid anti-icing agents and determine practices to reduce their detrimental impact on concrete durability and to improve use. Design and conduct laboratory experiments to study key parameters of liquid anti-icing application (e.g., concentration, application rate, application time, and frequency of application). Review anti-icing application recommendations in the Highway Maintenance Manual Criteria for quality control. Test bare concrete, sealed concrete and concrete with thin polymer overlays to determine relative effectiveness of these protection strategies.

Task 4: Mitigation Techniques and Life-Cycle Cost Analysis

Recommend practical mitigation techniques aimed at reducing the long-term impact on concrete pavements and bridge decks without compromising the effectiveness of anti-icing solutions as a winter pavement and bridge management tool. Conduct a life-cycle cost analysis to compare the life cycle costs of pavement, with and without recommended mitigation methods. This should include sealed concrete and concrete with thin polymer overlays.

Task 5: Recommendation and Guidelines

Develop recommendations and guidelines in a format consistent with the maintenance manual, Bridge Manual, WisDOT Facility Development Manual (FDM) (e.g., Chapter 14. Pavements), and associated presentation materials for WisDOT practitioners.

IV. Required Testing

A. Produce concrete in the laboratory conforming to current Wis.DOT STSP 715-005 utilizing Optimized Aggregate Gradation, sample and cure samples using the following procedures:

1. Sampling freshly mixed concrete (AASHTO R60)
2. Making and curing concrete test specimens (AASHTO T23)
3. Standard moist curing for concrete cylinders (AASHTO M201)

B. Perform concrete testing following these specifications:

1. Concrete compressive strength (AASHTO T22). Cast 6 - 6”x12” cylinders per mix design. Test two specimens each at ages 3, 7 and 28 days.
2. Air Content of Freshly Mixed Concrete by the Pressure Method (AASHTO T152)
3. Super Air Meter (SAM) (AASHTO TP 118)
4. Determining Air Content in Hardened Concrete (ASTM C457)
5. Resistance of Concrete to Chloride Ion Penetration (AASHTO T259)
6. Practice for Petrographic Examination of Hardened Concrete (ASTM C856)
7. Determining Chloride Ions in Concrete and Concrete Materials by Specific Ion Probe (AASHTO T332)
8. Standard Test Method for Scaling Resistance of Concrete Surfaces Exposed to Deicing Chemicals (ASTM C672)
9. Resistance of Concrete to Rapid Freezing and Thawing (AASHTO T161)

V. WisDOT/TOC Contribution

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

B. 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.

C. WisDOT staff/TOC members can be expected to contribute a maximum of 40 hours over the duration of the project.

D. The TOC and POC will coordinate access to the winter maintenance manual and any specification and guidance of concrete paving used in WisDOT.

VI. Required Travel

The Principal Investigator is required to travel to Madison to deliver the Close-Out Presentation in person.

VII. Deliverables

Submission of a PDF of the final report is required.

VIII. Schedule and Budget

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 starting around October 1, 2020.

IX. Implementation

A. This study will review and recommend application methods (or practical mitigation methods) with details. Recommendations should include, but not be limited to: type of anti-icing agents and their solutions, concentrate rate, application rate, time, and frequency, and maintenance strategy that can reduce the adverse impacts by applying commonly used anti-icing solutions in Wisconsin.

B. This study will recommend changes to existing concrete pavement construction and maintenance method/specifications and recommendations for use of new method(s), if any, for the future.

C. This study will recommend future inspection method(s) and frequency so that concrete pavement and bridge deck can perform adequately during expected service life.

D. The final research report and presentation will be used to develop training materials for industry professionals and WisDOT engineers.