



WHRP

Wisconsin Department of Transportation Wisconsin Highway Research Program

Request for Proposal

Evaluation of the Effects of Deicers 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 December 7, 2015

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) on December 14, 2015

Proposers must submit a PDF version of their proposal by 4:30 PM (CST) on January 22, 2016
to: research@dot.wi.gov

Proposers will be notified by May 1, 2016

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**

Evaluation of the Effects of Deicers on Concrete Durability

I. Background and Problem Statement

Deicer can affect concrete both physically and chemically. Physical effects are typically observed as cracking, and chemical effects can result from reactions involving cement hydration products, aggregates, or reinforcing steel (Sumsion and Gurthrie 2013)¹. Traditionally, rock salt (i.e., sodium chloride) in solid form has been the primary deicing chemical used for winter maintenance on Wisconsin's highway system. In recent years, two changes have been made regarding the use of deicers for highway maintenance in Wisconsin.

The first change involves the frequent use of a variety of newer deicing chemicals for highway maintenance, including calcium chloride, magnesium chloride, and some agricultural byproducts such as beet juice. These aggressive chemicals are known to cause rapid and severe distress to concrete such as significant reduction in the compressive strength, splitting tensile strength and microhardness occasionally without sign of surface distress. Various studies indicate that concrete exposed to calcium chloride and magnesium chloride experience significant deterioration, including scaling, cracking, mass loss and compressive strength loss compared to one exposed to sodium chloride. The second change is that many transportation agencies have introduced "anti-icing" practices of applying high-concentration liquid solutions of deicers to dry the pavement prior to the beginning of a snow event. This practice causes much more rapid ingress of the deicing chemicals because the dry concrete surface absorbs the anti-icing solution very readily, whereas the old scheme of applying rock salt to a wet, saturated concrete surface allowed for much less penetration of the deicing chemicals.

Sutter et al. (2008)² showed dramatic potential for damage to concrete from deicers based upon calcium chloride and magnesium chloride. In addition to tests that showed freeze-thaw related damage to the concrete, there were some tests that showed chemical attack causing damage to concrete test specimens with no freezing at all. Some significant conclusions have been found by studying field projects with joint distress related to joint action of freeze-thaw cycle and deicers such as magnesium

¹ Sumsion, E. S., & Guthrie, W. S. (2013). *Physical and Chemical Effects of Deicers on Concrete Pavement: Literature Review* (No. UT-13.09).

² Sutter, L., Peterson, K., Julio-Betancourt, G., Hooton, G., Van Dam, T., Smith, K., (2008). *The deleterious chemical effects of concentrated deicing solutions on Portland cement concrete* (No. SD2002-01-F).



chloride in addition to basic concrete parameters such as w/cm ratio and air void system characteristics. The microscopic evidence has suggested the concrete had been affected by both chemical and physical degradation by the joint action of freeze-thaw cycle and magnesium chloride.

Although these adverse impacts of various chemicals in deicer to concrete are commonly recognized, there is limited information on the usage of deicer in Wisconsin. For example, what kinds of chemicals are used as deicers in counties across the state? How does the use of different deicers impact pavement condition in Wisconsin? How long have various department and local governments been applying certain deicers? How old is the concrete that the deicer has been applied to, etc. This study is to investigate the commonly used deicers and their contents and identify the potential adverse impacts on the pavement.

II. Goals and Objectives

The goal of this project is to 1) identify the use of different deicers in Wisconsin and 2) investigate whether and how the currently used deicers adversely affect concrete durability and pavement condition.

The objectives of this project are to:

- Provide from published literature, an understanding of the effect of various deicers on concrete durability. Conduct a literature review and assessment of current practices at various other state DOTs.
- Perform a follow-up study (i.e., survey) to investigate what Wisconsin is using on roads for deicing, and the various adverse impacts of the commonly used deicers. Develop a plan to survey WisDOT roads based on the widespread use of various deicers. The plan should identify field survey locations within the State.
- Conduct a field survey of WisDOT concrete slabs to evaluate and confirm the effect(s) of the deicers on concrete durability.

III. Scope of Work

Task 1: Researcher will conduct a comprehensive literature review on premature durability failure along concrete slab and joints by aggressive usage of deicers with special emphasis on those studies and reports related to freeze-thaw climates. The researcher will report the results back to the Rigid Pavement Technical Oversight Committee (TOC).

Task 2a: Researcher will survey all areas of Wisconsin to identify the commonly used deicers. The survey will include, but not be limited to, state, county and municipal level



maintenance crews. The survey will identify the details of deicers that are being used in all concrete pavements such as highway, local road and ancillary concrete surfaces (sidewalk, curb and gutters, corrugated median islands etc.) in Wisconsin. Survey will include concentration rates and application conditions, and reporting and possible adverse impact of aggressive use of deicers at different concentrations. The survey will also be used by the researcher to identify potential field locations for Task 2b.

Task 2b: The researcher shall conduct a detailed field review by visual inspection to identify the relationship between various deicers and concrete durability. This task will validate the quality of data collected in Task 2b (e.g., concentration level of the brines, chemical makeup etc.) by assessing pavement condition based on the use of different deicers. Researcher shall cooperate with Project Oversight Committee (POC) members to select the sites.

Task 3: Researcher will provide a draft final report, analyzing the work in Task 1 and 2. The final report shall include, but not be limited to, Material Safety Data Sheet (MSDS) on all of the recognized deicing materials and a summary of their chemical makeup. The draft final report will be submitted to the Rigid Pavement TOC in advance of the final presentation. The researcher will present the results of this project to the Rigid Pavement TOC in person.

IV. Required Testing – none

V. WisDOT/TOC Contribution:

- Expected level by staff/TOC members: Maximum of 40 hours. Project Oversight Committee (POC) members will consult with research team in selection of project sites
- WisDOT Equipment: The research team 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.
- It is not anticipated that any WisDOT equipment will be needed as part of this study.
- Any traffic control, if needed, will be the responsibility of the researcher to coordinate with existing construction contractors and WisDOT personnel.

VI. Required Travel

This project will require travel for a meeting to finalize the work plan with the POC, evaluate slabs in Task 2b and travel to Madison is required to report the results of the study to the Rigid Pavement TOC in Task 3.



VII. Deliverables

- Submittal and reporting of progress as required by the WHRP and WisDOT
- Reporting Requirements. Seven (7) hard copies and an electronic copy of the final report delivered to WisDOT by the contract end date.
- Presentation Requirements. All projects require the Principal Investigator to give a closeout presentation after submittal of the draft final report.

VIII. Schedule and Budget

- Proposed Project Duration is **18 months** starting around October 1, 2016.
 - Deadline for submittal of draft final report is December 31, 2017.
 - Deadline for research closeout presentation is 4-6 weeks prior to contract end date.
 - Deadline for submittal of final report is March 31, 2018.
- Project Budget shall not exceed **\$60,000**. Matching funds will not be considered in the proposal evaluation process.
- The researcher is expected to submit the draft final 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.

IX. Implementation

This study will establish recommendations on the list of deicers that have been commonly applied in Wisconsin accompanied with their adverse impacts. The safety of the traveling public is of the utmost importance for WisDOT and should be considered within the recommendations. The researcher is expected to communicate the following:

- Recommended potential changes in practice.
- Recommended potential changes in materials.
- Benefits in terms of improved performance and cost savings.