



WHRP

Wisconsin Department of Transportation Wisconsin Highway Research Program

Request for Proposals

Chemistry and Performance of Supplementary Cementitious Materials (SCMs) for Wisconsin Concrete Pavement

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, 2022

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 14, 2022

Proposers must submit a PDF version of their proposal by 4:30 PM (CST) on February 4, 2022 to: research@dot.wi.gov.

Proposal Preparation Guidelines can be found at: [Proposal Preparation Guidelines](#)

Proposers will be notified by April 29, 2022

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 Technical Oversight Committee (TOC)
Request for Proposals for**

***Chemistry and Performance of Supplementary Cementitious Materials (SCMs)
for Wisconsin Concrete Pavement***

I. Background and Problem Statement

Supplementary Cementitious Materials (SCMs) such as industrial by-product fly ash, slag and silica fume provide essential benefits to concrete mixtures in terms of costs, strength, and durability. Currently, the Wisconsin Standard Specification (Spec 501.3.2.2.2) allows replacing 15% to 30% by weight of the total cementitious material content by SCMs. In Wisconsin, there are five approved SCMs for concrete pavement: Class C Ash, Class F Ash, Slag, Silica Fume and blended SCMs (Spec 501.2.4.2). However, their performances vary depending on their reactivity to other materials in the mixture. The chemical properties of SCMs (e.g., oxides contents) heavily depend on source and production process. So, understanding how the chemistry of these materials affect concrete properties and evaluating how the replacement levels correlate with performance (e.g., strength, durability, permeability overtime, scaling resistance, shrinkage, etc.) provide valuable information for long lasting concrete pavements.

In addition to the approved SCMs, the demand for non-traditional SCMs and reclaimed ashes as potential substitutions for traditional and approved SCMs is increasing. As the future supply of traditional SCMs has become uncertain as coal plants are closing or going offline, the concrete industry is looking for alternatives to replace traditional SCMs. Natural pozzolans, calcined clay, fluidized bed combustion (FBC) are examples of non-traditional SCMs. Reclaimed ashes, also a non-traditional SCM, can be obtained from landfills. However, engineers and industries are reluctant to use them due to their poor knowledge of the long-term performance and the lack of reliable guidance and specification to use them. Similar to the traditional SCMs, understanding the relationship between the chemical properties of the non-traditional SCMs and their pavement performance is the first step to build confidence in the use of non-traditional SCMs in Wisconsin.

The goal of this study is to investigate how the chemical properties of various SCMs impact short-term and long-term performance of concrete pavement by (1) identifying traditional SCMs, non-traditional SCMs, and reclaimed ashes available to Wisconsin, (2) evaluating how each of the SCM types have different chemical properties based on their sources and production process and (3) assessing how SCMs can contribute to the performance of concrete pavement (e.g., compressive and flexural strength,



permeability, surface resistivity etc.) in Wisconsin. All SCMs to be studied should include both traditional SCMs specified in Standard Specification (Spec 501.2.4.2) and non-traditional SCMs (e.g., natural pozzolans, calcined clay, and FBC, and reclaimed ashes available in Wisconsin). In particular, Wisconsin Department of Transportation (WisDOT) is interested in understanding the relationship between SCMs' chemical properties and the performance of concrete pavement so the knowledge base in Wisconsin practice can be expanded, especially when reclaimed ashes from landfills are available.

The successful completion of the study will develop a database that includes various SCMs, their sources and production process, their chemical properties, and expected pavement performance. The final product is intended to help develop, update, or confirm the SCM usages specified in WisDOT specification, CMM, FDM and other guidance. It includes Spec 501.2.4.2, Supplementary Cementitious Material (SCM), 501.2.4.3, Alternate Supplementary Cementitious Material (ASCM), 501.3.2.2.2, Supplementary Cementitious Materials.

II. Objectives

The research plan includes the following objectives.

1. Identify commonly used traditional SCMs, non-traditional SCMs, and reclaimed ashes for Wisconsin pavement.
2. Identify the chemical properties of each SCMs focusing on the material sources and production process that can contribute the pavement performance.
3. Develop a database with various SCMs, their chemical properties and pavement performance.
4. Develop, update, or/and confirm the WisDOT Specification related to SCMs.

III. Scope of Work

Task 1: Literature Review and Identification of SCMs used in Wisconsin

Conduct a comprehensive literature review to reveal commonly used SCMs and mix proportions for concrete pavements in the United States and across the world. This task should present the details of SCMs used in Wisconsin, including sources, chemical properties (e.g., oxide content), and their range, procedures, and usage limits to maximize the performance of concrete pavements. The literature review will also identify non-traditional SCMs such as calcined clays, natural pozzolan, ground bottom ash and fluidized bed combustions (FBC) fly ash, and reclaimed ashes that can be used to replace traditional SCMs in Wisconsin. The research team will share the findings from the literature review with the Project Oversight Committee (POC) and select the SCMs for the testing specified in Tasks 2 and 3.

Task 2: Identify the Chemical Properties of SCMs Available to Wisconsin

Within the collected information from Task 1, reveal the chemical properties of SCMs. Researchers should explore a wide range of SCM resources and should recognize the



variability of chemical properties within different sources available to Wisconsin pavement contractors. The detailed chemical components (e.g., different oxide contents) should be compared to each other, and the WisDOT content limits should be considered during the identification of the chemical properties. Based on the literature review, the researchers should also identify a range of usage limits for non-traditional and reclaimed ashes. The proposed usage limits must be shared with the POC for approval for Task 3 Laboratory Pavement Performance Testing.

Task 3: Laboratory Pavement Performance Testing

Conduct performance testing on concrete mixes. Researchers will follow WisDOT spec limits for traditional SCMs. For non-traditional SCMs and reclaimed ashes, the research team will use the usage limits identified during the completion of Task 2. The concrete mix performance will be studied using industry-standard for short- and long-term concrete testing, but the research team is also encouraged to proposed innovative laboratory-testing methods. The research team should incorporate WisDOT Standard Specifications in the evaluation of the concrete performance.

At the end of Task 3, an interim report summarizing the pavement performance testing results will be presented to the Project Oversight Committee (POC) for comment and approval.

Task 4: Develop A Database by Analyzing and Interpreting Lab Testing Data

The researchers will analyze and interpret the relationship between chemical properties and the short- and long-term concrete pavement performance. This task should also include suggested range of usage limits for SCMs reflecting the performance results. The suggested range of usage limits should accommodate the various products from diverse material sources and their processes. The research team will share their findings with POC members before developing recommendations.

Task 5. Develop Recommendations for SCMs Usage in Wisconsin Pavement Mix Design

Based on the analyses and interpretations of the laboratory data, the research team will propose recommendations and develop guidelines for the use of traditional SCMs, non-traditional SCMs, and reclaimed ashes for Wisconsin pavement mix design. Develop recommendations and guidelines in the WisDOT Standard Specification, Facility Development Manual (FDM) format. Recommendation and associated presentation materials should also be available to WisDOT practitioners. The recommendations and guidelines will then be used to update the current standard specifications for concrete pavements and improve the long-term concrete pavement performance.



Task 6. Final Report

The research team will prepare and submit a draft final report that will include project background, lab data analysis and interpretation, and recommendations for updated SCM application. As part of this report, the research team will include any data files collected from lab and field testing for future use, analysis, and interpretation.

Note- The selected research team will negotiate a contract that will include a Data Management Plan (DMP) that will document all the field monitoring data and analyses to ensure accessibility and transparency of research data as required by the Federal Highway Administration (<https://ntl.bts.gov/public-access/creating-data-management-plans-extramural-research>). The DMP will include the following items:

- *The final research data to be produced during the project;*
- *The standards to be used for data and metadata format and content;*
- *Policies for access and sharing the final research data, including provisions for appropriate protection of privacy, confidentiality, security, intellectual property, and other rights or requirements;*
- *Policies and provisions for re-use, re-distribution, and the production of derivatives; and*
- *Plans for archiving final research data and other research products, and for preservation of access to them.*

A Data Management Plan is not required as part of the proposal submission.

IV. Required Testing

- A. Produce concrete in the laboratory conforming to current Wis. DOT STSP 715-005 using the following procedures:
- a. Sampling freshly mixed concrete (AASHTO R60).
 - b. Making and curing concrete test specimens (AASHTO T23).
 - c. Standard moist curing for concrete cylinders (AASHTO M201).
- B. At a minimum, perform concrete testing following these specifications:
- a. Concrete compressive strength (AASHTO T22). Cast 6 - 6"x12" cylinders per mix design. Test two specimens each at ages 3, 7 and 28 days.
 - b. Flexural Strength (AASHTO T97) Cast 6 – 6"x12" cylinders per mix design. Test two specimens each at ages 3, 7 and 28 days for both lab and field testing.
 - c. Super Air Meter (SAM) (AASHTO TP 118).
 - d. Surface Resistivity (AASHTO T358).
 - e. Heat of Hydration of Hydraulic Cementitious Materials (ASTM C1702).
 - f. Quantifying Calcium Oxychloride Formation Potential (AASHTO T365).
 - g. Resistance of Concrete to Rapid Freezing and Thawing (AASHTO T161).

V. WisDOT/TOC Contribution

WisDOT will provide the following support through the Project Oversight Committee to support the successful completion of the project:

- A. Work will be conducted with project oversight by the WisDOT WHRP Rigid



Pavements Technical Oversight Committee (TOC).

- 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 applicable/available project cross sections.
- 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, signage, barricades, etc., as well as the duration needed (hours/day/location).
- F. The proposal must include discussion of specific traffic control support that is being requested from WisDOT. The researcher will need to coordinate the location 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.
- G. Researchers should not assume availability of contractors for sampling and testing.

VI. Required Travel

- A. This project requires meetings with the Project Oversight Committee to finalize the work plan and the researcher's fieldwork.
- B. This project that the principal investigator delivers the Close-Out Presentation.

VII. Deliverables

- A. Quarterly Progress Reports
 - a. WHRP contracts require quarterly technical progress reports that serve both technical and administrative functions.
 - b. Detailed information regarding the content of the progress report can be found at [Quarterly Progress Reports Guidelines](#)
- B. Invoices
 - a. Invoices shall be submitted quarterly for partial payments on the project for authorized services completed to date. Invoices may be submitted four times per year, one partial invoice for each specified quarter.
 - b. Detailed information regarding invoicing can be found at [Invoicing Requirements](#)
- C. Before Close-Out Presentation Report
 - a. A Before Close-Out Presentation report is required to be submitted three months before the contract end date to allow time for review, revision, and scheduling of the project Close-Out Presentation.
 - b. Reports are expected to have quality technical writing and proper grammar. It is acceptable to dedicate resources from your project for the services of a



technical editor to ensure these requirements are met.

- c. The required elements of the Before Close-Out Presentation report can be found at [Before Close-Out Presentation Requirements](#)
- D. Project Close-Out Presentation
 - a. The Principal Investigator on the research team is required to give a presentation to the Technical Oversight Committee.
 - b. Presentation and formatting requirements can be found at [Close-Out Presentation Requirements](#)
- E. After Close-Out Presentation Report
 - a. The After Close-Out Presentation Report is due within three weeks of the Close-Out Presentation for review and comments.
 - b. This report details the results of the research project. The final report should be as concise as possible (e.g., a maximum of 50 pages plus supporting appendices) and follow the report guidelines and submission requirements [After Close-Out Presentation Report Requirements](#)
 - c. After revision(s) and oversight committee chair approval, an electronic copy of the Publication-Ready Report must be delivered to WisDOT by the contract end date.

VIII. Schedule and Budget

- A. Project budget shall not exceed \$200,000. Matching funds will not be considered in the proposal evaluation process.
- B. Proposed project duration is 24 months starting around October 1, 2022.

IX. Implementation

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

- A. Comprehensive list of traditional and non-traditional SCMs used in the U.S. and internationally, and their limit for concrete pavement.
- B. Clear and concise commentary on the relationship between chemical properties of available SCMs in Wisconsin and short-term and long-term pavement performance.
- C. Recommendation to develop, update or confirm the existing specification regarding available and applicable SCMs and their limits.
- D. Recommendation to concrete pavement construction and maintenance method/specifications and recommendations for use of new method(s), if any, for the future.
- E. The final research report and presentation will be used to develop training materials for industry professionals and WisDOT engineers.
- F. The research team should discuss the access and storage of completed project data and analyses in a brief data management plan.