

**South Dakota Department of Transportation
Research Project Statement
Project SD2008-03**

Title: Evaluation of Warm Mix Asphalt Concrete Pavement in South Dakota Conditions

Problem Description: Highway construction techniques employing warm mix asphalt (WMA) have been introduced in the U.S. over the past few years as a means to allow pavement compaction at lower temperatures, increase construction efficiency, and provide for better environmental stewardship. Warm mix asphalt is produced at temperatures in the range of 30° to 100°F lower than typical hot mix asphalt (HMA). Because WMA is produced at a lower temperature than HMA, a primary benefit to using WMA is a reduction in fuel consumption when compared to the amount of energy needed to heat traditional HMA. Lowered temperatures during asphalt production allow for reduced emissions at the plant and around the paving site, but the resultant decreased fuel usage would also have the potential to reduce the construction costs for asphalt paving projects.

WMA lowers the viscosity of asphalt concrete. By lowering the viscosity, several resultant benefits might include better compaction, slower cooling rates, reduced mixture aging, allowances for longer haul distances, and more options for maintenance activities in colder weather like patching. These conditions may result in better capabilities to pave and compact at cooler temperatures, such as those experienced in South Dakota during the early and late construction season, and thus provide more options for paving operations during less than ideal weather conditions.

In order to assess the relative merits of employing WMA paving techniques in the state, the South Dakota Department of Transportation (SDDOT) would need to construct pavement test sections with WMA. The primary aims of WMA evaluations would be to:

- Examine the suitability of using WMA in South Dakota's climate.
- Assess WMA pavement and paving operations in overlays, interim surfacing, and/or leveling courses.
- Evaluate the mechanistic and chemical properties of WMA binders and mixtures.
- Assess the performance of quartzite, limestone, and natural gravels in WMA pavements, which are the 3 primary aggregate types native to South Dakota, and also perform similar assessments relative to various quantities by weight of recycled asphalt pavement (RAP).
- Ascertain the structural integrity, durability, and moisture susceptibility of WMA in comparison to conventional HMA pavements.
- Gain measures of relative emissions during production and paving with WMA as compared to HMA.

To fully accomplish the desired WMA assessment, the test pavement construction should not be a simple thin overlay or wearing course. A simple thin overlay wouldn't necessarily give a full representation of structural integrity. Also, paving operations should be scheduled late in the construction season when the weather is cooler to truly determine whether WMA placement is a viable alternative during less than ideal weather conditions. Finally, test sections would need to be monitored and measured for an extended period of time once construction is completed.

Importance: In light of the challenges that the SDDOT might be facing for some time given the current economic and energy climate, the use of WMA as a suitable alternative to traditional HMA may present some significant cost savings and possibly provide performance advantages. The potential advantages to be gained include extended workability, better compaction and thereby pavement performance, as well as likely emission reductions along with possible improvements to safety and working conditions. Other tangible benefits may include better cool weather (Spring & Fall season) paving operations whereby increased productivity during these periods of the construction seasons when marginal conditions often occur in South Dakota would provide better project schedule flexibility and additional surfacing alternatives for winter carryover pavements on multi-year projects.

Urgency: It will be necessary to initiate efforts to plan and construct WMA pavement toward the end of this year's construction season. Otherwise, any evaluation of WMA construction and performance would be pushed back at least one full year.

Literature Summary: Extensive literature exists on WMA, primarily through widespread demonstration projects that have occurred in Europe and the United States. However, there isn't any documentation available that characterizes the use of WMA where weather, construction materials, or other considerations could be related to South Dakota conditions.

Are Research results already available? Yes If so, how can SDDOT implement these results? The use of WMA in Europe and several demonstration projects in the United States identify many essential technologies and paving techniques associated with WMA construction. The SDDOT would be able to take these results and use them in planning, specifying, designing, and constructing WMA test pavement specific to South Dakota conditions.

In summary, does research need exist? Yes Explain: If the SDDOT wants to take advantage of an emerging paving practice that has many potential benefits, efforts aimed at determining the best course for paving with WMA relative to South Dakota's needs would be an essential activity.

Research Objectives:

- 1) Evaluate various types of WMA paving technologies to determine their suitability for use in South Dakota in various applications.
- 2) Assess the performance of WMA through construction of test sections and subsequent monitoring of the sections' performance over time.
- 3) Obtain cost versus benefit analyses relative to the constructability, performance, environmental factors, and other potential considerations.

Research Tasks:

- 1) Review and summarize literature that can be directly related to the construction and performance of WMA pavements in South Dakota.
- 2) Review the publication on the National Asphalt Pavement Association website, "Material Test Framework for Warm Mix Asphalt Trials" as this document will be used after modification based on discussions between the project Technical Panel and Research Team throughout the course of the work efforts. The Web link to the document is as follows:
http://www.warmmixasphalt.com/submissions/2_20071125_Material_Test_Framework_for_WMA_Trials_Dec2006.pdf
- 3) Develop a preliminary lab protocol and testing plan including appropriate testing procedures for the WMA mix designs to be reviewed and approved by the Technical Panel. This will be based on the South Dakota AC mix design procedure and should include appropriate WMA admixtures as indicated by the literature review at several dosage rates using typical South Dakota aggregates such as: limestone, quartzite, and natural gravel. Additional, limited testing should also be done using recycled asphalt pavement (RAP) in separate mixtures with quartzite and natural gravel aggregate at 20, 30, and 40 percent by weight of recycled material, and subjected to Asphalt Pavement Analyzer (APA) and tensile strength ratio (TSR) testing, at minimum.
- 4) Meet with the project's Technical Panel to review and discuss the project scope, preliminary work plan, and "Material Test Framework for Warm Mix Asphalt Trials."
- 5) Conduct preliminary testing and provide an interim report, for review and approval by the Technical Panel that includes initial lab test results and also the proposed test section matrix for WMA field trial sections.

- 6) Meet with tech panel to finalize testing plans and overview the proposed content plan notes.
- 7) Develop plan notes for the construction of WMA test sections that will incorporate all modifications to standard SDDOT plan notes and specifications for HMA pavements, including specifications for admixtures, special binders, and other additives, as well as necessary sampling and testing.
- 8) Document construction of the WMA test sections and HMA control sections, document emissions and energy reductions of WMA and HMA, and also conduct field testing and monitoring according to the “Material Test Framework for Warm Mix Asphalt Trials” as modified and agreed upon by the Technical Panel and Research Team. Field data to be collected will also include the number of passes of asphalt compaction equipment and results developed from thermographic imaging to be provided by the SDDOT, or else obtained during an “Intelligent Compaction” demonstration.
- 9) Conduct long-term performance monitoring of all WMA test sections and HMA control sections, including the testing of pavement core samples to be provided by the SDDOT over at least two winters.
- 10) Develop cost versus benefit analyses of WMA relative to the constructability, performance, environmental factors, and other potential considerations as compared to HMA.
- 11) Develop recommendations for the suitability, as well as the application of evaluation and acceptance procedures relative to new WMA technologies that could be incorporated into paving practices in South Dakota.
- 12) Prepare a final report and executive summary of the work efforts, findings, conclusions, cost versus benefit analyses, and recommendations.
- 13) Make an executive presentation to the SDDOT Research Review Board at the conclusion of the work efforts.

Potential Implementation: The work efforts would provide an effective means to assess the workability, structural integrity, potential cost savings, and any other beneficial aspects of employing WMA paving mixes in South Dakota. Results of the work could lead directly to acceptance of WMA as a routine paving alternative with potentially beneficial applications

Budget Estimate: \$140,000 months 48 months

Funding: SPR

SDDOT Involvement: The SDDOT will need to generate thermographic imagery during WMA construction for subsequent analysis by the researchers. Pavement samples will also need to be cored, collected, and shipped by the Department during the long-term monitoring aspects of the proposed efforts. Finally, the SDDOT Materials & Surfacing office will need to work closely with the researchers in developing plans for lab and field testing, as well as during development of mix designs.

Recommendation: Contract Research **Explain:** The scope of this project will require work to be performed over an extended period of time and necessitate the use of varied amounts of resources, materials, and equipment, particularly where lab work is concerned, that is not otherwise available to the Department.

Technical Panel

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 Kevin Carlson.....Jebro Inc.
 Wayne Cramer..... Aberdeen Region
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