Opportunities for WHRP to Support WisDOT Efforts to Implement the MEPDG (DRAFT)

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The draft final report submitted by Applied Research Associates (ARA) and presented to WisDOT statewide bureaus and regional personnel, industry, and academia on October 6, 2008 described research efforts related to the Mechanistic Empirical Pavement Design Guide (MEPDG) and identified future directions to fully implement the technology. The 2005-2010 WHRP strategic plan includes the specific task of facilitating WisDOT's efforts related to implementation of MEPDG. Definition of this strategic objective in 2005 resulted in over $500,000 of completed research used by ARA to develop the recommendations in the Phase I report. Furthermore, WHRP is currently funding in-progress research at a level exceeding $500,000 to support MEPDG.

Recommendations submitted by the ARA research team clearly defined research needs, logistical challenges, and policy issues that need to be addressed as WisDOT transitions from the AASHTO 1972 procedure to MEPDG. The breadth and scope of the outstanding issues provide many opportunities for WHRP to support WisDOT in their implementation efforts through all of the pavement materials and management related technical oversight committees.

Materials Inputs

Flexible Pavements TOC

Discussion after the presentation identified five material inputs needed to support the proper use of the MEDPG:

1. **HMA Dynamic Modulus (E*):** Develop a catalogue of values for commonly used mix designs, at a minimum testing will be conducted at the frequencies and temperatures required by MEPDG. *WHRP funded project 0092-08-06 to catalogue E* values. Research is currently in progress, it is the responsibility of the TOC to ensure test conditions are consistent with WisDOT needs for MEPDG implementation. Targeted Completion: May 30, 2009*

2. **HMA Flow Number (FN):** Develop a catalogue of values for commonly used mix designs with test conditions consistent with MEPDG requirements. Research project includes both unconfined testing per NCHRP 9-33: A Mix Design Manual for Hot Mix Asphalt and Flow Number testing with confining pressure as specified in NCHRP 9-30A: Calibration of Rutting Models for HMA Structural and Mix Design. The use of confinement pressure will be evaluated as the project progresses. *WHRP funded project*

0092-09-01 to catalogue FN values. Common mix designs used between the E and FN projects. Targeted Completion: March 30, 2011.*

3. **HMA Indirect Tensile Properties:** HMA resistance to fatigue and thermal cracking is estimated using the parameters of indirect tensile strength and creep compliance. WisDOT does not have any data related to these parameters for mix designs commonly used in Wisconsin. A catalogue of values for mix designs should be developed to allow for input of material properties consistent with Wisconsin materials. The previously mentioned research projects included a matrix of mix designs selected by the Flex TOC, these materials should be collected and used to create a catalogue of IDT properties. *WHRP Fiscal Year 2010 RFP estimated duration October 1, 2009 – December 31, 2010.*

4. **Relationship Between Total Asphalt Content and Effective Asphalt Content:** Effective asphalt content is one of the parameters used in the model to estimate dynamic modulus when direct measurement of the property is not possible or feasible. The relationship between total asphalt content and effective asphalt content can be established using data currently provided in WisDOT approved mix designs. The data should be synthesized to obtain ranges of effective asphalt content based on mix type, aggregate source, and asphalt content. *Investigation of these relationships is on hold pending results of national research efforts related to developing improved test methods for measuring aggregate specific gravities.*

5. **Database of Binder Properties:** HMA performance depends on both mix and binder properties. More reliable estimates of performance could be attained through input of actual values of complex modulus (G*) and phase angle (δ) at various testing temperatures into pavement design rather than only considering binder PG grade in design. Binder grades and sources commonly used in Wisconsin should be used to develop a catalogue of the required values.

The outstanding HMA mechanical property input is being addressed by the TOC using a Fiscal Year 2010 Request for proposal. The project is developing a catalogue of the required HMA indirect tensile properties necessary for estimating low temperature cracking. The TOC will encourage the researcher to include some of the same mix designs and materials sampled for the Dynamic Modulus and Flow Number research projects currently in-progress in their experimental design. The other effort would be a data gathering project using mix design data submitted to WisDOT by contractors to develop design guidance summarizing the dependence of aggregate source, mix type, mix gradation, and total binder content on effective binder content. Execution of this project is pending results of national research and internal discussion at WisDOT.

Rigid Pavement TOC

1. **Catalogue of Coefficient of Thermal Expansion:** WHRP conducted one study cataloging CTE values of common mix designs, however the values provided were considerably higher than those reported nationally. Use of higher values would result in more rapid predicted deterioration of the pavement leading to an over-designed pavement section. The values of the previous research need to be modified or accepted and potentially CTE values for more concrete mixes measured. There is also a research opportunity to develop a model to predict CTE values based on other material properties.

2. **Concrete Mix Modulus of Elasticity:** MEPDG requires E_c be estimated using the chord modulus after 7, 14, 28, and 90 days curing. Modulus testing is conducted in compression, collection of this data is a need for WisDOT. The research project should also focus on correlation of modulus to compressive strength and non-destructive methods such as use of sonic waves. Poison's ratio can be calculated during testing and should be collected to provide inputs to the design guide.

3. **Concrete Indirect Tension Testing:** The MEPDG recommends obtaining tensile strength values through flexural testing of a concrete beam. Due to sample preparation time and sample variability, correlation between flexural strength and split tensile strength should be investigated and the design guide analyzed to evaluate how split tensile strength data can be used in MEPDG. Testing should be conducted after 7, 14, 28, and 90 days.

The Rigid Pavements TOC has posted a Request for Proposal with the intent of collecting fresh and hardened concrete properties from a wide range of aggregate types and cements, and supplemental cementious materials to support the implementation of MEPDG. The project is scheduled to start October 1, 2009 and has a duration of 27 months (ending December 31, 2011).

Geotech TOC

1. **Resilient Modulus Testing of Unbound and Recycled Materials:** WisDOT has funded numerous research projects in this area through WHRP research focused on M_r values of both unbound and recycled materials. Research on the unbound materials included development of models to predict M_r as a function of material properties, whereas only M_r values for recycled materials were collected. Many of the research projects are currently in the review stage, in the short term the Geotech TOC must conduct detailed review of these projects and develop recommendations on how to move forward to support the transition to MEPDG.

2. **Mechanistic Methods to Consider Contribution of Stabilized Bases to Design:** The Geotech TOC also has funded and provided oversight for numerous projects analyzing the effects of geo-grid or chemical stabilization on resilient modulus. These projects are currently in the review stage, results of the review should be used to guide potential specification changes and identify research needs.

The Geotech TOC currently has many research efforts that require review and TOC action before determining how the research results can be incorporated into MEPDG. Potential areas of further work include resilient modulus testing to include a range of materials consistent with aggregate sources and stabilization alternatives used throughout the state. Further efforts could also focus on evaluation and possible implementation of current models to estimate resilient modulus, including but not limited to the work being conducted by Dr. Hani Titi in WisDOT projects 0092-03-11 and 0092-08-12.

Consideration of Overlays

HMA overlays and to an extent PCC overlays are an integral part of WisDOT's current pavement maintenance and rehabilitation strategies. WHRP has conducted research projects outlining construction and design methodologies for overlays, however no project has provided design information to the level of detail required in MEPDG. Consideration of MEPDG for overlays will be considered after mechanistic design procedures for standard pavements have been established.

Database of Pavement Sections for Local Calibration

In their short term recommendations, ARA recommends at least two conventional HMA and PCC projects from each region be used for local calibration. Activities would include detailed performance evaluation and characterization of the in-place materials. There is an opportunity for WHRP to aide WisDOT through development and execution of a testing plan for collection of inputs for MEPDG, and comparison of actual to predicted performance to develop calibration coefficients. The project would also require development of a database to store all the materials and performance data. Efforts related to this task would require a collaborative effort across TOCs to provide proper oversight and input to the research project. In the long term there are recommendations for MEPDG validation and local calibration that include development of a more comprehensive data set using a wider range of pavement types, more pavement sections, and further material testing.

Further short term activities involve conducting parallel designs between MEPDG and the current AASHTO 1972 methodology. Depending on the number of parallel designs the department wants to run, WHRP TOCs could scope a project and select a researcher to conduct

the designs. Again this would be an effort including multiple TOCs to aide development of project scope, researcher selection, identification of pavement sections, and project oversight.

Before addressing either the short or long term needs specific to pavement sections in terms of validation/calibration, it was made clear that the current data collection systems in place are inadequate for calibration purposes. It was recommended that the level of detail in terms of materials inputs and performance data required for meaningful calibration should be kept in a separate database structure that is independent of the conventional network level performance data that is collected.

In conclusion, there are many opportunities for WHRP to support MEPDG implementation efforts from both a materials and pavement design perspective. Detailed review of this document by appropriate WisDOT managers and WHRP TOCs can help identify other opportunities for collaboration.