MPC-391

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Project Title: Implementation of Low Temperature Test for Asphalt Mixtures to Improve the Longevity of Road Surfaces

University: The University of Utah

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Research Needs:
Asphalt concrete pavements make up over 90% of the transportation network's surface. Recent demands for increased use of environmentally sustainable materials have resulted in mixtures with different additives, including Recycled Asphalt Pavement (RAP) and Recycled Asphalt Shingles (RAS). However, for these materials to be truly sustainable, they must provide some long-term benefit or, at the very least, not be detrimental to the performance of the asphalt mixture. To deal with this issue the Utah Department of Transportation (UDOT) has been implementing the use of mechanical tests such as the Hamburg Wheel Tracking Device (WTD) to screen asphalt mixtures that might not have adequate high-temperature performance due to either mixture instability or incompatibility between components. The implementation of the Hamburg WTD as a screening test has significantly benefited the high temperature performance of asphalt pavements. However, it has not addressed the low and intermediate temperature performance reflected as thermal and fatigue cracking. Premature pavement failures have been observed that can be directly linked to inadequate intermediate and low temperature properties resulting in millions of dollars in maintenance cost. **This proposal seeks to address this problem by developing a set of performance tests and specification to address the intermediate and low temperature properties of asphalt mixtures.**

A significant effort was undertaken during the past years to measure low temperature properties of asphalt mixtures by using the Bending Beam Rheometer (BBR) to test small beams made out of asphalt concrete (http://www2.udot.utah.gov/main/uconowner.gf?n=4493029359845211). While the work showed how the device can successfully be used in a laboratory environment, analysis of field samples are needed to develop the required specification limits and establish a balance between the high and the low temperature properties of asphalt mixtures thus ensuring longer lasting, cost effective, sustainable pavements no matter what additives are used.

Research Objectives:
The objectives of this study are to gather field data to select specification limits for the low temperature properties of asphalt mixtures placed on Utah roads (and possibly the Mountain West region). Specifically, it proposes to accomplish the following objectives:

1. Characterize low temperature properties of asphalt concrete field materials used in Utah during the duration of the study.

2. Establish a relation between laboratory design and field properties of hot mix asphalt.
3. Study the effect of recycled materials (RAP or RAS) on the low temperature properties of these asphalt mixtures.
4. Develop a specification limit to balance the high and low temperature properties of the asphalt mixtures currently being placed on the roads.

Research Methods:

To accomplish the study objectives, the following tasks are proposed.

1. **Analysis of Field Projects** - Field projects constructed within the last 3 years throughout the state of Utah will be selected. Approximately 10 will be from pavements that have shown little to not cracking and a similar number will be from pavements that have shown significant cracking. For each project cores will be obtained then cut into thin beams and tested using the established BBR protocols at 3 temperatures (Low PG +4, low PG +10, and low PG +16). The data will be analyzed, standard parameters will be extracted, and the low critical cracking temperature will be determined.
2. **Laboratory Designs** – For each of the projects selected in Task 1, aggregate, RAP, and binder will be obtained to prepare laboratory samples based on the job mix formula (JMF). These samples will be cut, tested, and the data will be analyzed in the same manner as in Task 1. This will determine the changes between design and field material as well as aging (note that this will be the combined effects which cannot be separated).
3. **Comparison of high RAP designs to virgin designs** – One project that was constructed with high RAP content will be selected for further study. The same aggregate, same gradation, and same binder that was prepared with RAP will be compared to the same design but without RAP. This will allow isolating the effect of RAP on the mixture and thus provide some guidance regarding the addition of materials that can potentially harden the mix and help assess its sustainability. An example of such results is shown on the figure 1. The figure clearly show how the increase in RAP content for the same mix results in an increase in cracking temperature (less temperature resistance).

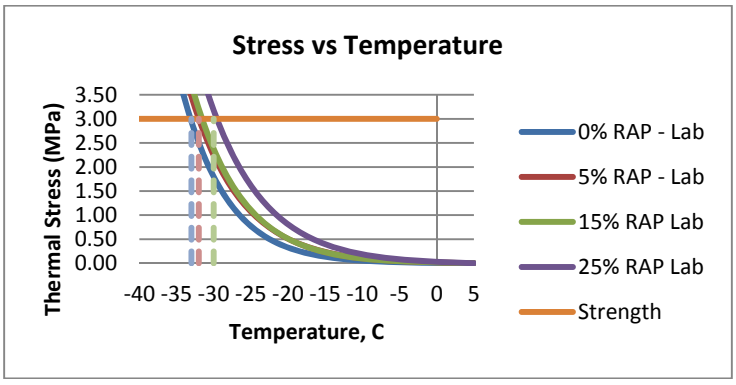


Figure 1 – Preliminary data showing the effect of different RAP content on an asphalt mixture

4. **Specification Limits** - Based on the performance of the field projects from Task 1, the differences between mix design and field material as determined in Task 2, and the effect of high RAP on the virgin mix as determined in Task 3, a specification limit will be established that ensures adequate low temperature performance while maintaining high temperature properties.

5. **Final Report** – A final report will be written and a presentation to UDOT staff will be scheduled for final approval of the report and eventual publication. The report will contain the results from the previous tasks as well as recommendations.

Expected Outcomes:
This project will result in the following outcomes:

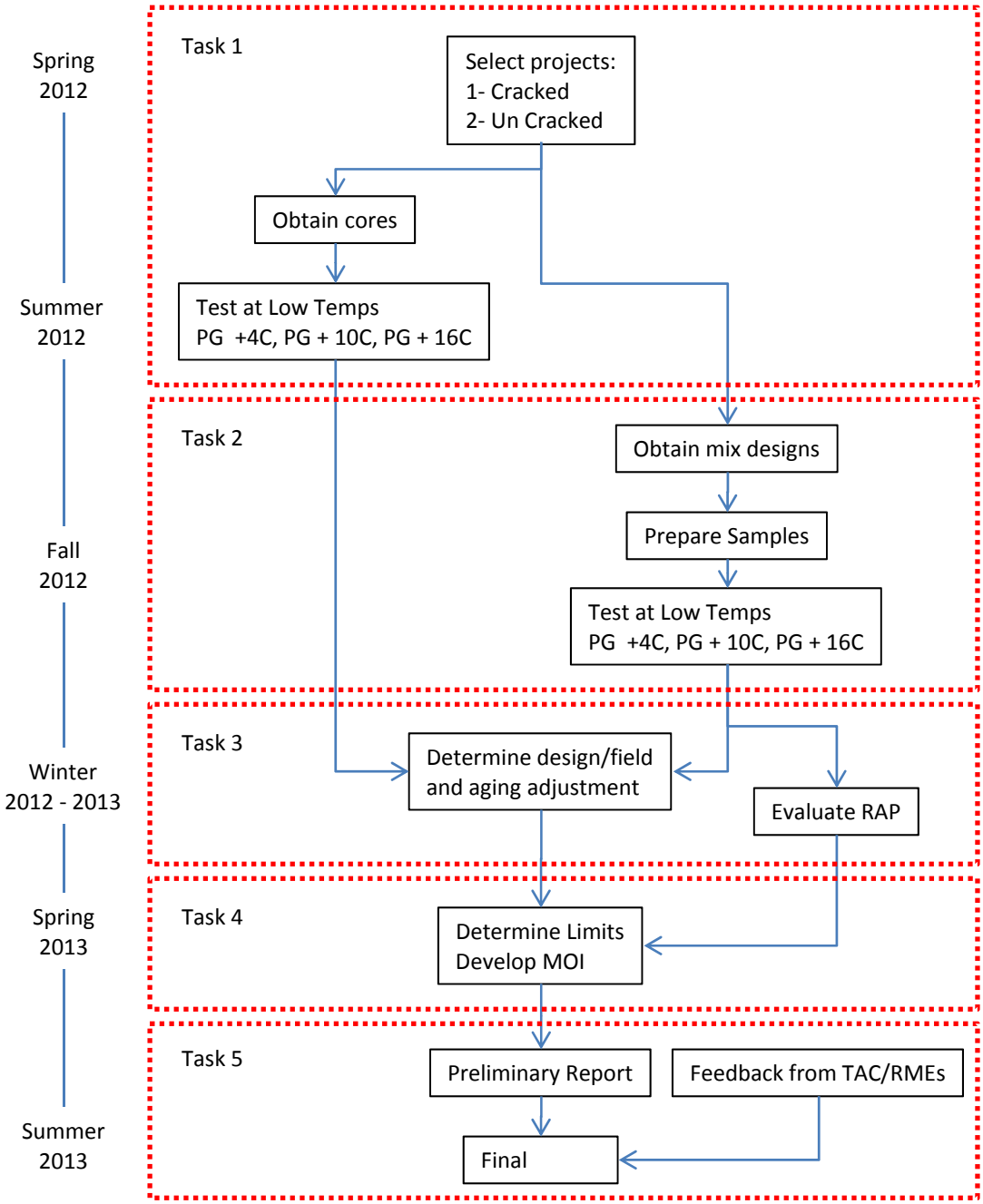
1. Low temperature characterization of mixtures evaluated as part of this study. These mixtures should be representative of the material used in Utah roads.
2. A Manual of Instruction (MOI) with specification limits that will restrict hard, brittle mixtures from being placed on the road and allow incorporation of sustainable value added-additives (e.g., RAP) without affecting long-term pavement performance.

Relevance to Strategic Goals:
State of Good Repair Strategic Goal: by developing a performance-based specification of asphalt mixtures, as proposed in this project, highway agencies can ensure the quality and longevity of road surfaces. This will reduce the need of road repairs and extend the time between rehabilitation and reconstruction of highways.

Environmental Sustainability Strategic Goal: the use of a performance-based specification of asphalt mixtures will allow for innovation and an increase use of environmentally sustainable or recycled materials (e.g., RAP or RAS). By relying on actual mixture testing, state highway agencies can reduce the need for prescriptive-type specifications and encourage new ideas in materials, construction, and innovative techniques to mitigate the effects of transportation infrastructure on the environment.

Educational Benefits:
This project will have several educational benefits. It will provide funding for at least two students to allow them to pursue an advance degree in engineering. Furthermore, two or more undergraduate students will also be involved in the project and will be encouraged to pursue careers in the transportation sector. It is the philosophy of the PI that, to solve the issues facing the transportation community, it is not enough to fund students that are already pursuing engineering degrees; we must also encourage future students to join the transportation engineering field. As such, the results from this project will be incorporated into a comprehensive outreach program that includes: (1) development of lesson plans that will be distributed to high school math and physics instructors relating course content to real life applications; (2) visits to selected high schools where students will use the findings from this project to present real-life applications and examples on how we are improving our communities; and (3) a week long summer camp during June 2012, in cooperation with other engineering disciplines, where high school students be will immerse in the ongoing research, they will talk to researchers and be asked to provide their solutions to the problems. Summer 2012 will be the fifth camp for the PI. Information about these activities can be found at http://www.coe.utah.edu/k12/programs.php

Work Plan:
The workplan for this project is shown in the figure below. The figure presents the tasks and the estimated time requirements of approximately 18 - 20 months.



Project Cost:
Total Project Costs: $75,515
MPC Funds Requested: $31,515
Matching Funds: $44,000
Source of Matching Funds: Utah Department of Transportation

TRB Keywords: asphalt, pavements, performance testing, specifications