**TRANSPORTATION POOLED FUND PROGRAM**

**QUARTERLY PROGRESS REPORT**

Lead Agency (FHWA or State DOT): Minnesota Department of Transortation

**INSTRUCTIONS:**

*Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.*

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| **Transportation Pooled Fund Program Project #***(i.e, SPR-2(XXX), SPR-3(XXX) or TPF-5(XXX)*TPF-5(132) | **Transportation Pooled Fund Program - Report Period:**C:\Program Files\Microsoft Office\MEDIA\OFFICE14\Bullets\BD21301_.gif□Quarter 1 (January 1 – March 31)□Quarter 2 (April 1 – June 30)□Quarter 3 (July 1 – September 30)□Quarter 4 (October 1 – December 31) |
| **Project Title:**Investigation of Low Temperature Cracking in Asphalt Pavements - Phase II |
| **Name of Project Manager(s):**Tim Clyne | **Phone Number:**651-366-5473 | **E-Mail**tim.clyne@state.mn.us  |
| **Lead Agency Project ID:**Contract 89261 | **Other Project ID (i.e., contract #):**WO # 103 | **Project Start Date:**6/17/08 |
| **Original Project End Date:**1/31/12 | **Current Project End Date:**7/31/12 | **Number of Extensions:**1 |

Project schedule status:

□ On schedule □ On revised schedule □ Ahead of schedule □ Behind schedule

Overall Project Statistics:

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|  **Total Project Budget** |  **Total Cost to Date for Project** |  **Percentage of Work**  **Completed to Date** |
| $505,000 ($475k research; $30k admin) | $305,660 (+ 6 TAP meetings) | ~85% |

***Quarterly*** Project Statistics:

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|  **Total Project Expenses**  **and Percentage This Quarter** |  **Total Amount of Funds**  **Expended This Quarter** |  **Total Percentage of**  **Time Used to Date** |
| 0 | $172,090 | 91% |

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| **Project Description**:The Minnesota Department of Transportation initiated this pooled fund study as a continuation of a long-standinginvestigation of low temperature cracking. The Phase I pooled fund study was aimed at developing a fracture mechanics-based specification for a better selection of asphalt binders and mixtures with respect to their resistance to crack formation and propagation.  The Phase I study has developed new models for intrinsic material properties, laboratory testing behavior, and mixture performance in an in-service pavement. An integrated approach that combines laboratory materials testing, numerical modeling, and prediction of pavement performance is taken in Phase II of this study. Part of this approach will include field validation of the aforementioned tests and models by constructing 3 test sections at MnROAD.  The main objective of this project is to develop test methods and specification criteria that will allow the selection of fracture resistant asphalt mixtures and binders at low temperatures. |

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| **Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):***Task 3, Develop low temperature specification for asphalt mixtures* – Task 3 was submitted and approved in March 2012. This report was submitted through four individual reports documenting particular pieces of each of the 3 subtasks:* Task 3.1 & 3.2: Low Temperature Mixture Specifications
* Task 3.3a: Creep Compliance from DCT & SCB
* Task 3.3b: Creep Compliance from BBR
* Task 3.3c: Single Edge Notched Beam

This task detailed the DCT test method, equipment that is needed to perform the test, costs of this equipment, and time required to prepare specimens and perform the test. The main outcome of this task was a table outlining specification limits of fracture energy for low, moderate, and high traffic levels. The spec limits were based in part on comparing laboratory and field data collected during both phases of the pooled fund study, as well as on modeling efforts through Illi-TC. The task concluded with several discussions of simplified methods to obtain creep compliance of asphalt mixtures.*Task 4, Develop Improved TCMODEL* – Final verification of the ILLI-TC program was conducted, with excellent results obtained. Comparison of model predictions against the commercial code ABAQUS was performed as a means of model verification. Finalization of the graphical user interface for the ILLI-TC program was also accomplished. Model calibration was also initiated this quarter, which involved collecting material property, field performance data, climate data, and pavement structure data from selected MnROAD sections from Phase I. Even before calibration, the ILLI-TC model prediction match with field data was quite reasonable. Inputs for model validation were also collected during this quarter, and model validation will occur in April. Other progress: additional work was conducted to supplement the work already submitted for Task 3. The concept of obtaining creep compliance from the DC(T) was further validated.*Task 5, Modeling of Asphalt Mixtures Contraction and Expansion Due to Thermal Cycling* – Task 5 was submitted and approved in March 2012. The coefficient of thermal expansion (CTE) of asphalt materials is a non-linear function of temperature, and its impact on low temperature performance can be as important as stress relaxation and fracture properties. Serious errors in estimating thermal stresses can occur by using default values of CTE. The findings from Task 5 can be used to:* Modify thermal stress estimation model in ILLI-TC by using more realistic values for CTE above glass transition and inclusion of Tg.
* Select proper CTE values either from typical experimental results obtained in this Task with the Asphalt Thermal Cracking Analyzer (ATCA) or from the micromechanical model proposed (i.e., CTE of mix is function of aggregate skeleton microstructure, the glass transition, and the stiffness ratios of the phases). Use these values in MEPDG or current version of ILLI-TC for better prediction of thermal cracking.
* Conduct testing of a wider range of mixtures for thermo-volumetric properties using the recently developed ATCA to enhance the CTE and Tg database.

*Task 6, Validation of New Specification* – This task is conducted in parallel with Task 4. Once Task 4 is submitted, the model will be further validated with the mixtures from the sections selected as part of the validation process. This task should be completed by middle of May.*Task 7, Development of Draft AASHTO Standards and Final Report* – Work has continued to assemble the research from each task in the draft final report. Following the Expert Task Group Meeting in March, a draft SCB testing method was submitted to the Mixture ETG chair that will take it to the AASHTO Subcommittee on Materials (SOM). |
| **Anticipated work next quarter**:The Task 4 report will be submitted by UIUC to the University of Minnesota during the first week of May. Task 6 should be completed by middle of May. Selected results of the modeling efforts from Task 4 will also be used for purposes of validating the proposed thermal cracking specification.Once the other task reports are delivered, Task 7 work will be finalized in a short period of time. Delivery of the Draft Final Report is expected by May 21, 2012.The University of Minnesota will submit a request for a No Cost Time Extension to allow time for revisions to the final report and publishing thereof. The request will be granted by MnDOT if the remaining tasks are submitted by May 21, 2012. |

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| **Significant Results:**Researchers are narrowing in on specification limits for the chosen asphalt mixture fracture test, the DCT. These spec limits will differentiate between good and poor performers in terms of low temperature cracking. AASHTO standard test methods have been proposed for the SCB and BBR mix tests.  Significant improvements have been made to ILLI-TC. This model will be a stand-alone program with a graphical, user-friendly interface.  The University of Wisconsin has developed sophisticated testing and modeling techniques to account for thermal stress buildup in asphalt mixtures.  Statistical analyses performed by ISU have shown that the DCT test does a good job differentiating between mixtures and their different parameters. |
| **Circumstance affecting project or budget. (Please describe any challenges encountered or anticipated that** **might affect the completion of the project within the time, scope and fiscal constraints set forth in the** **agreement, along with recommended solutions to those problems).** |

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| **Potential Implementation:** MnDOT and the other participating states may potentially revise their bituminous paving specifications to include a low temperature fracture test based on the results of this study. Iowa is in the process of developing performance specifications around the DCT test this year.  The states need to decide for themselves how the results of the study will be implemented. MnDOT is in the process of developing our “HMA Implementation Plan” through discussions between the Research Section and Bituminous Office.The MnDOT TL has applied for funding through both the Research Services Implementation Program and Destination Innovation to use the DCT test method and mixture specification on several construction projects in the 2012 and 2013 construction seasons. The goal of these proposals is to take what we’ve learned in the pooled fund study and apply it to real-world construction projects in Minnesota. |