Investigation of Low Temperature Cracking in Asphalt Pavements
National Pooled Fund Study 776
Work Order 128

Quarterly Report
August 9 to October 15, 2004

General Project Information

The contract between Minnesota Department of Transportation started with an effective date of August 9, 2004. As of October 15, 2004 only University of Illinois have submitted their subcontract documents to the University of Minnesota. The subcontract with Michigan Tech is in the process of being finalized and the subcontract with University of Wisconsin will be submitted by the end of the year.

A project meeting was held on September 30th in the Civil Engineering Department at the University of Minnesota to discuss the field sampling part of Task 2. The notes are available on the pooled fund web site.

Task 1 – Literature review

This quarter

The University of Minnesota started to work on the literature review.

Next quarter

This work will continue and it is expected to be finished by the end of 2004.

Task 2 – Identify pavement sites and laboratory materials

This quarter

A meeting was held on September 30th to discuss the field sampling program. Following the meeting a selection form was sent out to the participant states.

Next quarter

It is expected that the forms from all participating states will be received by November 30th. Based on the nominated sites a priority list will be developed and detailed sampling instruction for the selected sites will be sent out. A meeting is scheduled during TRB in January 2005 to discuss the progress of the field sampling. It is possible, weather permitting, to obtain some of the field samples during this season.

Task 3 – Laboratory specimen preparation and experimental testing

This quarter

Following the September 30th meeting Michigan Tech team is in the process of identifying the binder sources and the two aggregate sources for preparing the laboratory specimens.

Next quarter
It is expected that Michigan Tech will identify and obtain the required amounts of materials by the end of the quarter. Following the meeting at TRB in January lab specimen preparation activities will start.

Task 4 – Analysis of results

This quarter
No activities to report.

Next quarter
It is expected that no activities will be reported.

Task 5 – Modeling

This quarter
University of Illinois has hired a post-doctoral student and the research team started to look at some of the various analyses that can be used for the activities required in this task. More details are provided at the end of this document (see next page).

Next quarter
The activities performed in the first quarter will continue in this quarter.

Task 5 – Final Report

This quarter
No activities to report.

Next quarter
It is expected that no activities will be reported.

Activity	Month											
	2	4	6	8	10	12	14	16	18	20	22	24
Task 1. Literature review												
Task 2. Identify pavement sites and laboratory materials												
Task 3. Laboratory specimen preparation and experimental testing												
Task 4. Analysis of results												
Task 5. Modeling												
Task 6. Final report												

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Elastic fields of a pavement resting on a granular base or fully bonded to an elastic base have been studied in the first quarter of the pooled fund study considering the presence of thermal cracks typically observed in cold climates. The analysis endeavors towards the accurate prediction of crack spacing in asphalt pavements, but will also provide a valuable series of closed-form solutions that can be used by pavement modelers to verify numerical solutions (i.e., finite element results) against rigorously established standard solutions.

A two-dimensional theoretical solution is derived and validated by comparison to numerical simulations. This theory has been applied to calculate the energy release rate of thermal cracking and to measure the fracture toughness of the pavement materials. A simple method for obtaining an approximation of crack spacing is presented, which involves comparison of the energy release rate and the fracture toughness of the pavement at low temperature. It is found that, given the fracture toughness of the pavement and the maximum thermal loading, there is a critical thickness of the overlay below which no crack will initiate. This critical thickness not only depends on the fracture quantities of the overlay, but also on the elastic modulus or the frictional coefficient of the base layer.

An extension of this work to rigorously consider crack initiation and crack propagation in the pavement and to visualize the elastic field evolution with the thermal loading is underway. For the current work, the pavement materials are assumed to be linear elastic, but a viscoelastic constitutive model for the bulk material and nonlinear temperature field along the depth of the pavement will ultimately be considered. FEM simulations by DIANA will be proposed and compared with the theoretical work.

We are also in the process of recruiting a Ph.D. student to work on the U of I research team. The student would be responsible for all mechanical testing at U of I, and would also assist with field work, laboratory data breakdown, analysis, and would conduct some numerical simulations in conjunction with Dr. Huiming Yin and the two faculty PIs on the project. An offer has recently been made to an outstanding candidate.