CTS Project Number: 2008077
Project Title: Investigation of Low Temperature Cracking in Asphalt Pavements: National Pooled Fund Study Phase II
Reporting Period: Jan 1 - Mar 31 (2010)

<u>Task Number 2 : Expand Phase I test matrix with additional field samples</u>
Percent Task Complete: 90%

The disk-shaped compact tension (DC[T]) testing of specimens is currently underway at UIUC. The gyratory compacted specimens were prepared by the University of Minnesota. Researchers from University of Illinois obtained the specimens during the last project review meeting and transported them to the UIUC ATREL lab in Rantoul, IL.

A draft SCB specification was presented at the mix ETG meeting in Irvine. Revisions to the draft are currently made to address comments from the group.

It is expected that all testing and analysis will be completed by end of next quarter.

<u>Task Number 3: Develop low temperature specification for asphalt mixtures</u>
Percent Task Complete: 45%

Work has been started on all 3 subtasks.

For subtask 1, a SCB draft specification was presented to the ETG in February and UofM team is investigating the possibility of simplifying the test procedure.

In subtask 2, the supporting field and experimental data used to develop the current PG binder system was investigated.

In subtask 3, BBR thin mixture creep tests were performed and strength tests will start soon.

It is expected that this task will be completed on time.

<u>Task Number 4: Develop Improved TCMODEL</u>
Percent Task Complete: 70%

Significant progress had been made on the low temperature cracking prediction model during this quarter. The bulk and fracture simulation models are now implemented in a computer code written in the "C" programming language. The simulation model uses the finite element method to determine the thermal cracking rate in the pavement. The fracture code is based on a cohesive zone fracture model (CZM). The material property inputs for the CZM will be the tensile strength of material as well as the fracture energy. A numerical solution scheme based on Krout's solver is implemented; this was necessary due to the non-linearity of the problem. The viscoelastic material behavior is evaluated using a recursive-incremental numerical integration scheme. The next steps in finalizing the software include developing links between the analysis code and a user friendly graphical user interface (GUI) and to include the climatic prediction model for determining the temperature distribution within the pavement. The GUI was developed last year and was discussed during the last project review meeting at Maplewood (October, 2009). At this stage, linking of viscoelastic bulk response of the material with the cohesive zone fracture model is underway. It is anticipated that the analysis engine will be ready by the end of the summer of 2010.

Task Number 5: Modeling of Asphalt Mixtures Contraction and Expansion Due to Thermal Cycling
Percent Task Complete: 35%

In this quarter, efforts were focused on modeling and testing the thermo-volumetric behavior of asphalt binders and mixtures with special emphasis on the effect of thermal cycles on the glass transition temperatures and coefficients of thermal expansion/contraction (i.e., Task 5).

The newly developed dilatometric device was used to obtain Tg and coefficient of thermal contraction/expansion of the eight binders proposed in Task 2 (i.e., expansion of phase I test matrix) and four binders from field validation sections proposed in Task 6. Two replicates were tested for each binder. Generally, good repeatability is observed among replicates. Further improvements to the dilatometric device were achieved. To improve the efficiency of the system, a second dilatometric cell was added to the device to run two tests simultaneously. The considerable differences observed for the Tg of the binders highlighted the ability of this test to discriminate different binders.

Additional tests were performed in this quarter to investigate the effect of the application of several thermal cycles on the glass transition temperature and the contraction/expansion coefficients of binders. Three thermal cycles were applied to the binders. Preliminary results indicate that there are no significant changes observed in the Tg and the coefficients of thermal expansion/contraction after each cycle. Furthermore, the area inside the volume-temperature loop increases with each cycle, which indicates that the binder has a hysteretic type of behavior during thermal cycles.

Task Number 6: Validation of new specification
Percent Task Complete: 5%

Loose mix and binders for all test sections were delivered to UofM. A part of the binders were sent to UW for aging and testing.

It is anticipated that testing will start this summer.

Task Number 7: Development of draft AASHTO standards and Final Report
Percent Task Complete: 0%