Investigation of Low Temperature Cracking in Asphalt Pavements Phase II Project Meeting

Maplewood, MN

November 18, 2009

LTC - Phase II

- Continue phase I research effort and
  - Expand set of field materials tested, with focus on newly reconstructed MnRoad cells
  - Propose test method to determine fracture properties
  - Propose low temperature criteria for mix specification
  - Investigate thermal cycling of mixtures and binder physical hardening effects
  - Improve TCModel

Timeline

Start: 06/08

End: 01/12

1/31/2009 Task 1 deliverables due - Summary report; Update on Low Temperature Cracking Research

4/30/2010 Task 2 deliverables due - Summary report; Database with Test Date, Expansion of the Phase I Test Matrix, with additional field samples

10/31/2010 Task 3 deliverables due - Summary Report; Developed Low Temperature Specification, for asphalt mixtures

7/31/2011 Task 4 deliverables due - Summary Report; Developed Improved TCMODEL

7/31/2011 Task 5 deliverable due - Summary Report; Modeling of Asphalt Mixtures Contraction and Expansion Due to Thermal Cycling

7/31/2011 Task 6 deliverables due - Summary Report; Validation of New Specification

11/30/2011 Task 7 deliverables due - Final Report; Developed Draft AASHTO Standards

	Month												
	3	6	9	12	15	18	21	24	27	30	33	36	40
Task 1. Lit. review													
Task 2. Testing													
Task 3. Specification													
Task 4. TC model													
Task 5. Contraction													
Task 6. Validation													
Task 7. Final report													

- **Task 1 – Update on low temperature cracking research**
  - Document new research in the area of low temperature cracking

- Update:
  - Final revision in progress (90%)
  - Re-revised version delivered by end of November

- **Task 2 – Expand Phase I test matrix with additional field samples**
  - New asphalt mixtures used in field studies will be tested and analyzed with respect to their low temperature cracking resistance
  - Tests will consists of IDT creep and strength tests as well as SCB and DC(T) fracture tests

- Update:
  - All cylinders compacted except NYS 7%
  - All IDT testing completed except NYS
  - SCB testing in progress (20%)
  - DCT: UIUC team picks up cylinders and starts testing

Location	Construction Date	Description
MnROAD 33	September 2007	58-34 Acid only no RAP
MnROAD 34		58-34 SBS + Acid no RAP
MnROAD 35		58-34 SBS only no RAP
MnROAD 77		58-34 Elvaloy + Acid no RAP
MnROAD 20	August 2008	58-28, 30% non-fractionated RAP, level 4 SP, wear & non-wear
MnROAD 21		58-28, 30% fractionated RAP, level 4 SP, wear & non-wear
MnROAD 22		58-34, 30% fractionated RAP, level 4 SP, wear & non-wear
Wisconsin 9.5 mm SMA	2008	
New York State "Typical Mix"	2008	with PG 64-22 binder and an aggregate other than limestone and granite.

➢ Note change in test matrix: original table

Test Device	Temp	Mix Conditioning	MN/Road Test Section				SMA WI		Mixture NYS	
			33, 34, 35, 37		20, 21, 22					
			Air Voids, %							
			4	7	4	7	4	7	4	7
SCB	PG	4Hours@135ºC	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG+10ºC	4Hours@135ºC	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG	None	xxx		xxx		xxx		xxx	
	PG+10ºC	None	xxx		xxx		xxx		xxx	
DC(T)	PG	4Hours@135ºC	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG+10ºC	4Hours@135ºC	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG	None	xxx		xxx		xxx		xxx	
	PG+10ºC	None	xxx		xxx		xxx		xxx	
IDT	PG	4Hours@135ºC	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG+10ºC	4Hours@135ºC	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG	None	xxx		xxx		xxx		xxx	
	PG+10ºC	None	xxx		xxx		xxx		xxx	

➢ New table with field cores and long term aging

Test Device	Temp	Mix Conditioning	MN/Road Test Section				SMA WI		Mixture NYS	
			33, 34, 35, 37		20, 21, 22					
			Air Voids, %							
			4	7	4	7	4	7	4	7
SCB	PG	None	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG+10ºC	None	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG	5 days@85ºC		xxx		xxx		xxx		xxx
	PG	cores		xxx		xxx		xxx		xxx
DC(T)	PG	None	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG+10ºC	None	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG	5 days@85ºC		xxx		xxx		xxx		xxx
	PG	cores		xxx		xxx		xxx		xxx
IDT	PG	None	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG+10ºC	None	xxx	xxx	xxx	xxx	xxx	xxx	xxx	xxx
	PG	5 days@85ºC		xxx		xxx		xxx		xxx
	PG	cores		xxx		xxx		xxx		xxx

- **Task 2 – Subtask on physical hardening**
  - Develop protocol to simplify the measurements of physical hardening (reduce conditioning time) and include a numerical approach to adjust S and m values
  - Collect physical hardening for variety of binders and verify model that will be developed in task 5
  - Use glass transition measuring technique to quantify effect of isothermal storage on dimensional stability of asphalt mixtures

- Update:
  - Binders were delivered to Wisconsin
  - Wisconsin team will detail progress of research

- **Task 3 – Develop low temperature specification for asphalt mixtures**
  - Subtask 1 – develop test method
    - Refine and possibly simplify the SCB and DC(T) fracture tests used in phase I
    - Update: minimal progress
    - Propose a standard fracture test method based on SCB configuration for asphalt mixtures. Note that the DC(T) has been already approved as an ASTM D7313-06 standard
    - Update: a draft ASTM specification for SCB, similar to DCT, is almost complete (90%). It will be presented at mix ETG meeting in 02/10 for comments before being submitted
      - Need champion to take it to ASTM

- **Task 3 – Develop low temperature specification for asphalt mixtures**
  - Subtask 1 – develop test method
    - Develop standard fracture method. At the end of this task the research team *will recommend only one fracture test* but provide correlations between the results from the two methods
    - Update: minimal progress. Discussions have started between UIUC, UMN and mix ETG members to propose round robin for the two methods using at least 2-3 mix designs and 5 or more labs.

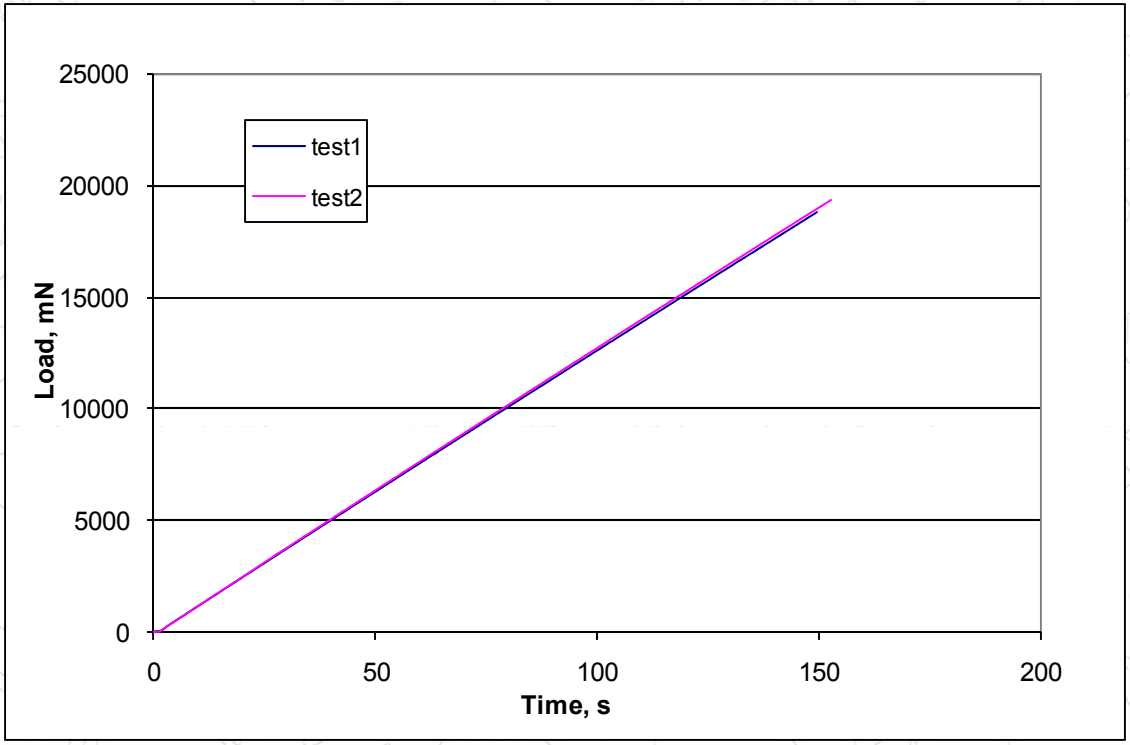
- **Task 3 – Develop low temperature specification for asphalt mixtures**
  - Subtask 2 – develop specification
    - Revisit field and experimental data that used to develop the current PG system; similar approach, based on criteria providing limiting temperature values, will be used for the mixture specification
    - Update: a review of the data and the assumptions used in developing PG was performed and is 90% completed

- **Task 3 – Develop low temperature specification for asphalt mixtures**
  - Subtask 2 – develop specification
    - Based on the experimental work performed in phase I and the work performed in task 2 and data available in previous research projects, develop limiting criteria for selecting asphalt mixtures resistant to low temperature cracking
    - Update: no progress

- **Task 3 – Develop low temperature specification for asphalt mixtures**
  - Subtask 3 – propose simplified method to obtain mixture creep compliance
    - Directly from SCB and DC(T) configuration
    - Update: no progress
    - BBR testing of thin asphalt mixture beams
    - Update: NCHRP Idea work finalized; results indicate that BBR can be used to obtain creep compliance of asphalt mixtures at temperatures around the PG limit of the binders

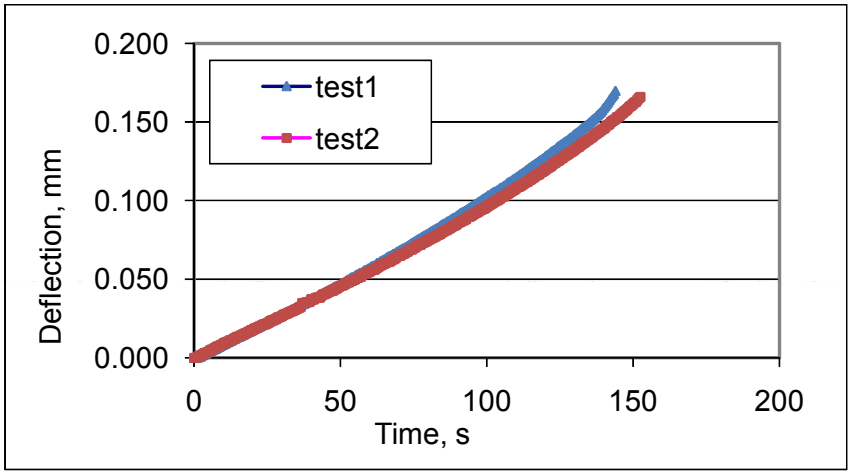
- **Task 3 – Develop low temperature specification for asphalt mixtures**
  - Subtask 3 – propose simplified method to obtain mixture creep compliance
    - Investigate if strength can be obtained from BBR testing of thin asphalt mixture beams to failure
    - Update:
      - Preliminary work at UMN showed that beams can be broken using modified BBR, see next slides
      - Wisconsin will provide update for ARC work performed by University of Wisconsin

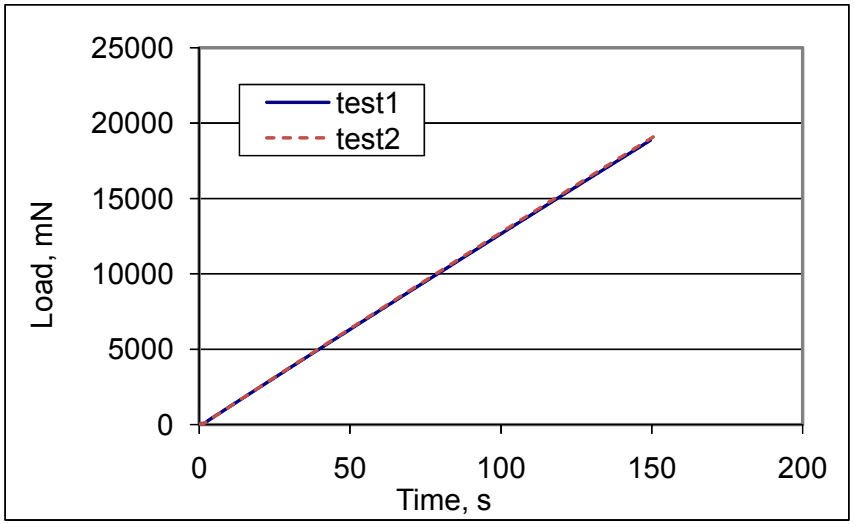
BBR Fracture Testing – Preliminary Results



- Heavier load frame received from Cannon
  - Capable of applying 10kgf (compared to 1kgf)
- Improvised device using water flow at constant rate allowed preliminary fracture testing of thin mixture beams with reasonable results

BBR Fracture Testing – Preliminary Results





BBR Fracture Testing

- Cannon Instruments has recently delivered proportional valve control
  - Allows loading at constant loading rate
- New system will be capable of performing both creep and strength tests on mixture and binder beams

- **Task 4 - Develop Improved TCMODEL**
  - Similar to MEPDG, although it will use mixture fracture tests instead of tensile strength and will have an improved fracture model (cohesive zone fracture model instead of the Paris law model)

- Update:
  - UIUC team will detail progress of research

- **Task 5 - Modeling of Asphalt Mixtures Contraction & Expansion Due to Thermal Cycling**
  - Expand data base for thermo-volumetric properties of asphalt binders and mixtures
  - Develop micromechanics model
  - Conduct sensitivity analysis to determine parameters statistically important for cracking
  - Task will be coordinated with ARC project

- Update:
  - Wisconsin team will detail progress of research

- **Task 6 – Validation of new specification**
  - Based upon the outcomes of the testing of the preliminary validation experimental plan, the best test device and method of conditioning mixes for long-term aging will be selected for the final validation
  - Validation will be based upon testing of the 11 Olmstead County, Minnesota mixes placed in the 2006 construction season

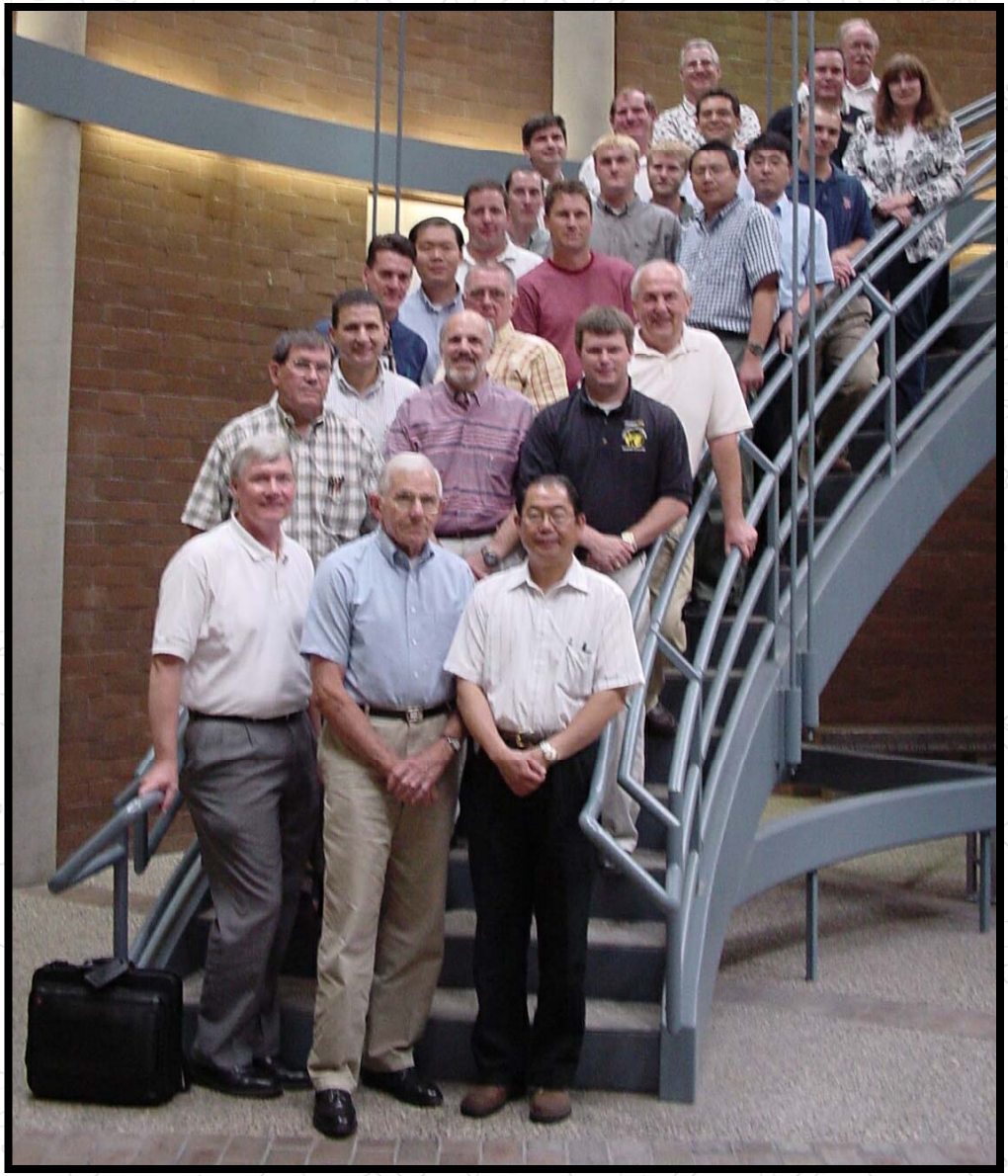
- Update:
  - No activity to report

Location	Constr. Date	Description
Olmsted Co Rd 104	Jul-07	Reinke's Warm Mix (58-28 w/ RAP & antistrip)
Rd 112	Aug-06	WRI-Mathy Study (Citgo, 58-28, 12.5 mm)
Rd 112	Aug-06	WRI-Mathy Study (Citgo, 58-28, 19mm)
Rd 112	Aug-06	WRI-Mathy Study (Marathon, 58-28, 12.5 mm)
Rd 112	Aug-06	WRI-Mathy Study (Marathon, 58-28, 19mm)
Rd 112	Aug-06	WRI-Mathy Study (MIF, 58-34 RAP, 12.5 mm)
Rd 112	Aug-06	WRI-Mathy Study (MIF, 58-34 Virgin, 12.5 mm)
Rd 112	Aug-06	WRI-Mathy Study (MIF, 58-34, 19mm RAP)
Rd 112	Aug-06	WRI-Mathy Study (MIF, 58-34, 19mm virgin)
Rd 112	Aug-06	WRI-Mathy Study (Valero, 58-28, 12.5 mm)
Rd 112	Aug-06	WRI-Mathy Study (Valero, 58-28, 19mm)

- **Task 7 - Development of Draft AASHTO Standards and Final Report**
  - Final report containing updated reports from task 1 to 6 will be delivered plus
    - Access database of experimental results
    - Proposed test protocols
    - Software and documentation for improved TCMODEL). Stand alone program and user manual will be provided

- Update:
  - No activity to report

Thank You!



August 2003 Initial Meeting
University of Minnesota