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

Northland Inn, Minneapolis

October 5, 2011

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 and deliver new TC Model

Timeline

Start: 06/08
End: 07/12

Task 3:	December 31, 2011
Task 4:	January 31, 2012
Task 5:	January 31, 2012
Task 6:	February 28, 2012
Task 7:	March 31, 2012
End date:	July 31, 2012

	Month										
	4	**8**	**12**	**16**	**20**	**24**	**36**	**39**	**42**	**45**	**48**
Task 1. Lit. review											
Task 2. Testing											
Task 3. Specification											
Task 4. TC model											
Task 5. Contraction											
Task 6. Validation											
Task 7. Final report											

- **Tasks 1 and 2 were delivered and approved**
  - Including subtask on physical hardening

- Task 2 needs to be changed for the final report to include new test data for the analysis:
  - NYS field cores were delivered last week
  - Wisconsin field cores were retested at the correct temperatures
    - Waiting for DCT results from UIUC

Materials

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	PG 64-22
New York State "Typical Mix"	2008	with PG 64-22 binder and an aggregate other than limestone and granite.

Testing matrix

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 3 – Develop low temperature specification for asphalt mixtures

- Subtask 1 – develop test method
  - ✓Research team delivered detailed comparison and recommendation with respect to fracture method : use DCT for which ASTM standard available
  - ✓SCB final draft submitted to mix ETG for final discussions before moving forward to AASHTO materials committee
  - ✓Discussions have started with mix ETG to propose round robin for the two methods using at least 2-3 mix designs and 5 or more labs. Most likely, round robin will occur after end of project.

- **Task 3 – Develop low temperature specification for asphalt mixtures**

  - Subtask 2 – develop specification
    - A review of the data and the assumptions used in developing PG was performed and is completed.
    - Analysis is almost finished to find out if binder PG limits (BBR stiffness and m-value) can be used to predict similar asphalt mixture limits
    - Fracture data was gathered and analysis is almost complete to identify a similar limit for fracture properties.
      - Additional test data obtained in other projects is also used in this analysis

DCT Fracture Energy

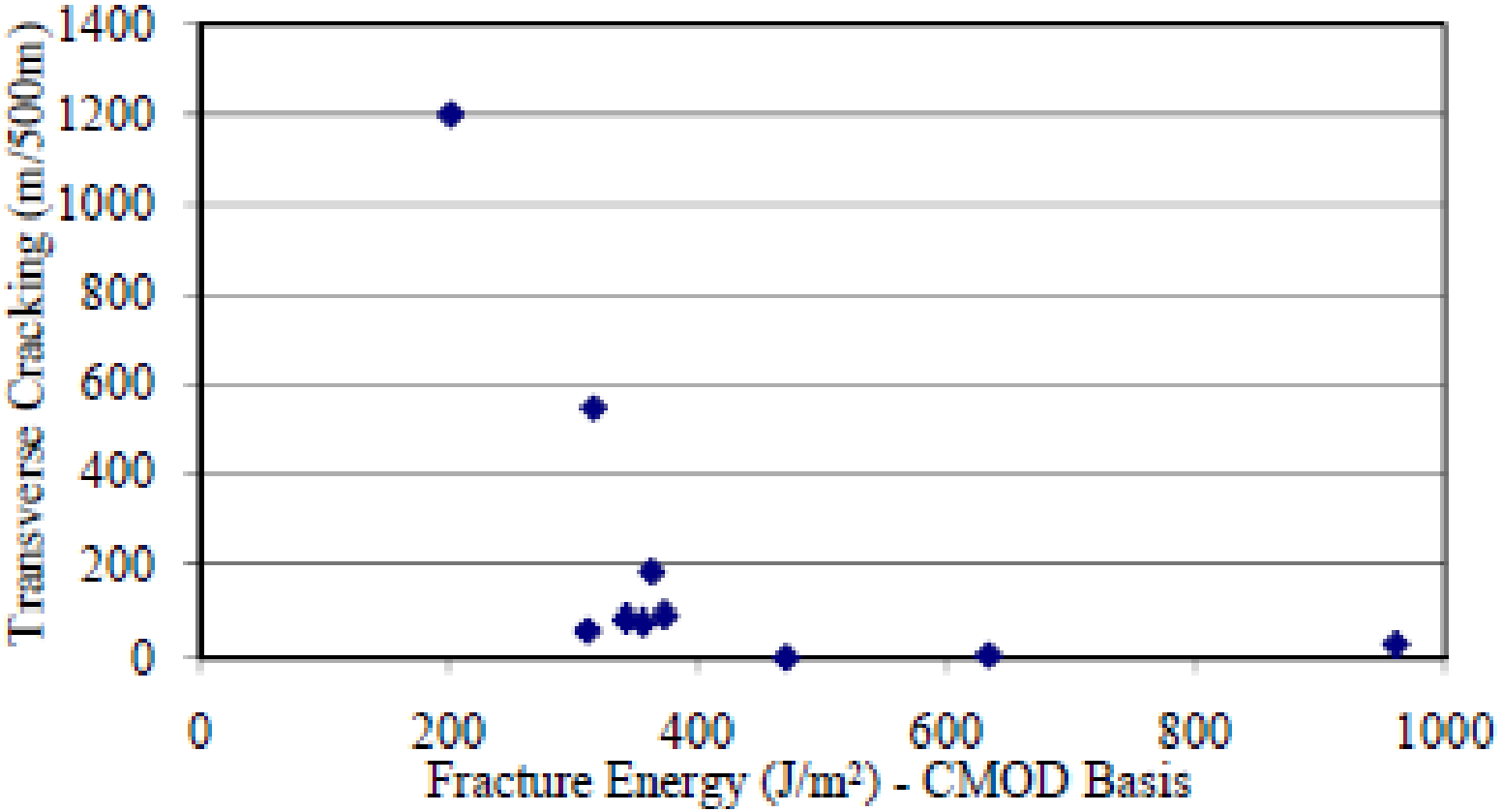
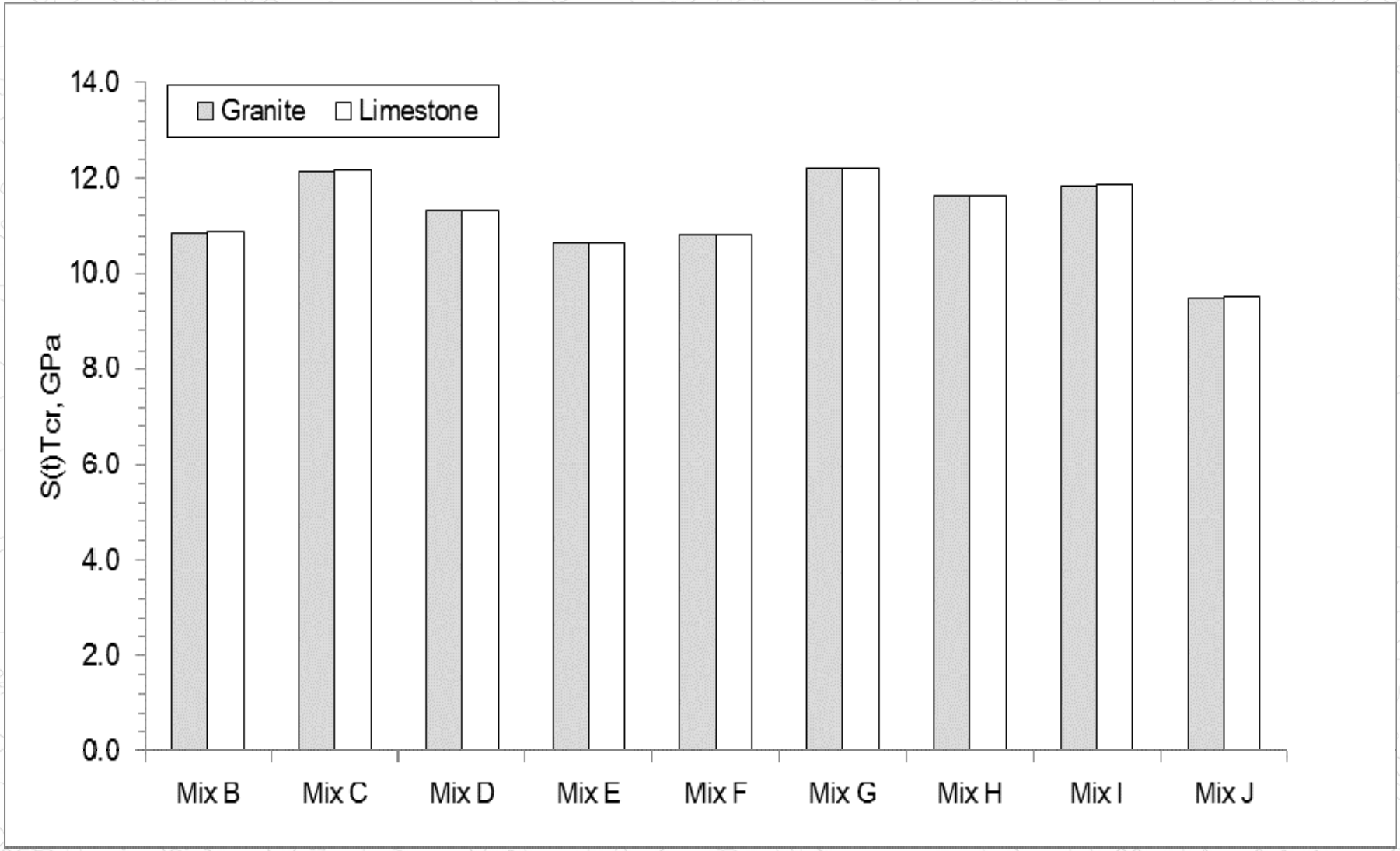


Figure 27. DC(T) Fracture Energy at PG Low Temp Grade +10C (12)

Transverse cracking frequency was minimal if the pavement core fracture energy average was greater than 400J/m2.
DC(T) specimens producing fracture energies greater than 400J/m2 correlate best with the least cracked pavement sections.

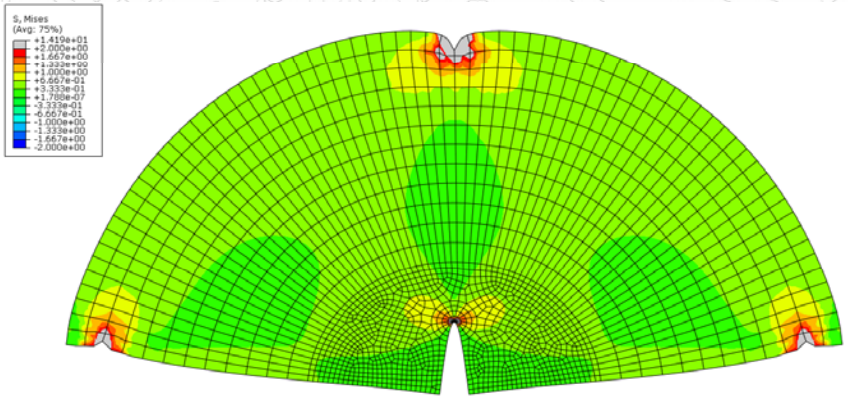
Stiffness Limit - Mixtures

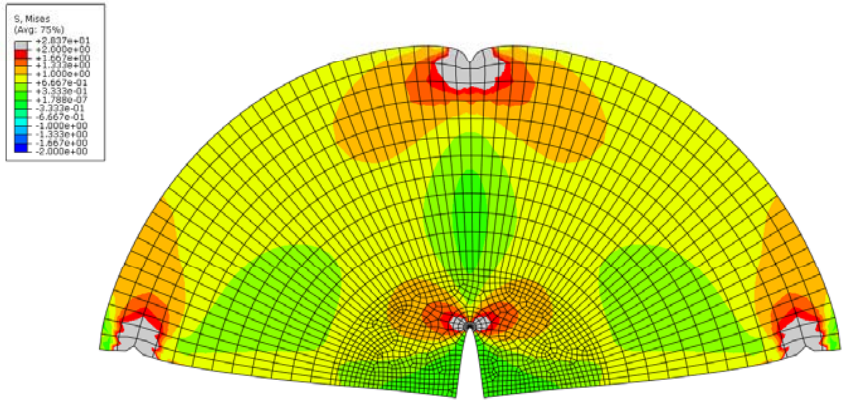


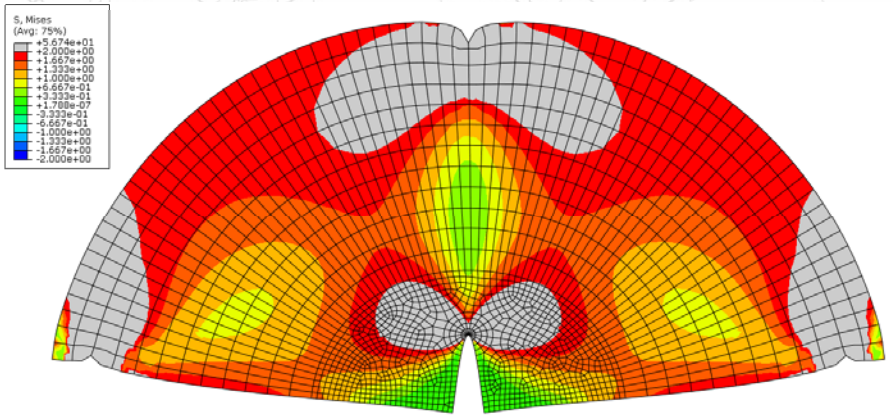
- **Task 3 – Develop low temperature specification for asphalt mixtures**

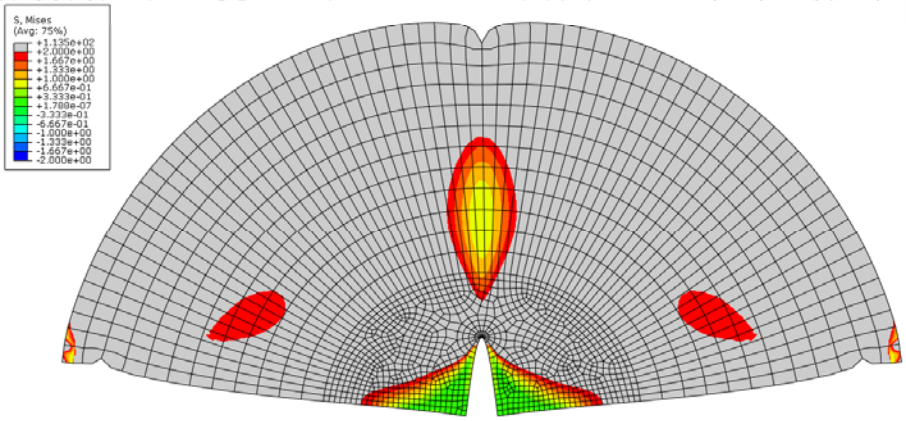
  - Subtask 3 – propose simplified method to obtain mixture creep compliance
    - ✓Directly from SCB and DC(T) configuration
      - Work on SCB almost finalized
      - Update on DCT from UIUC

Stress analysis



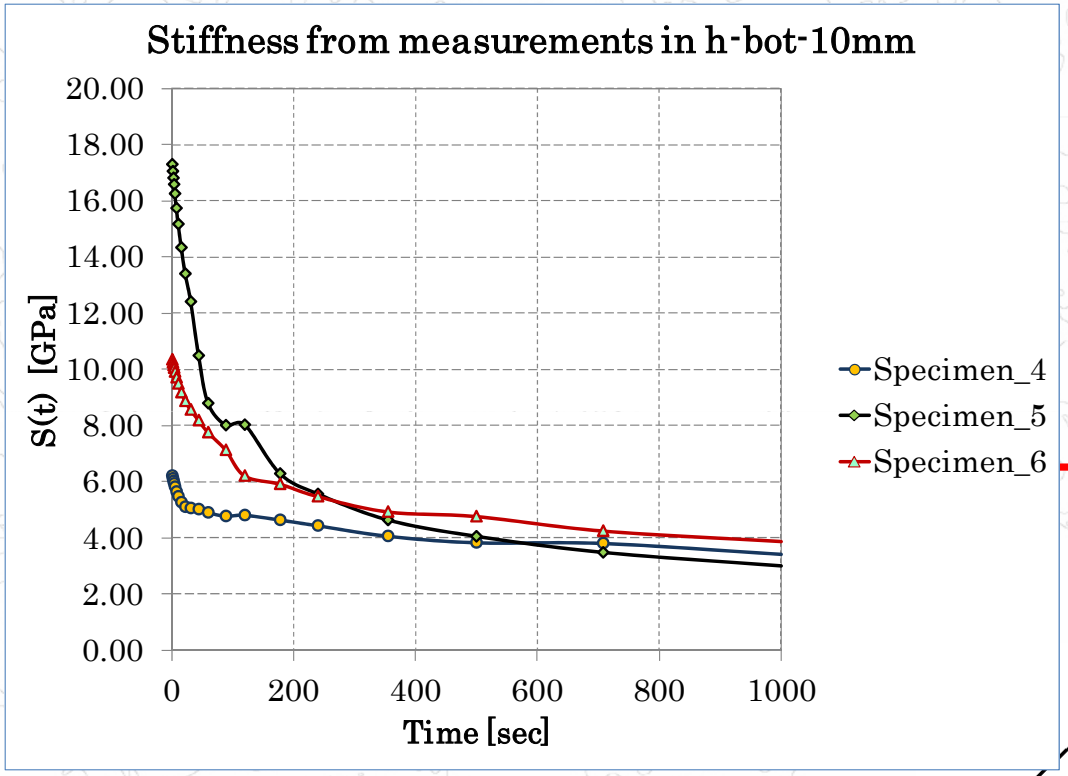




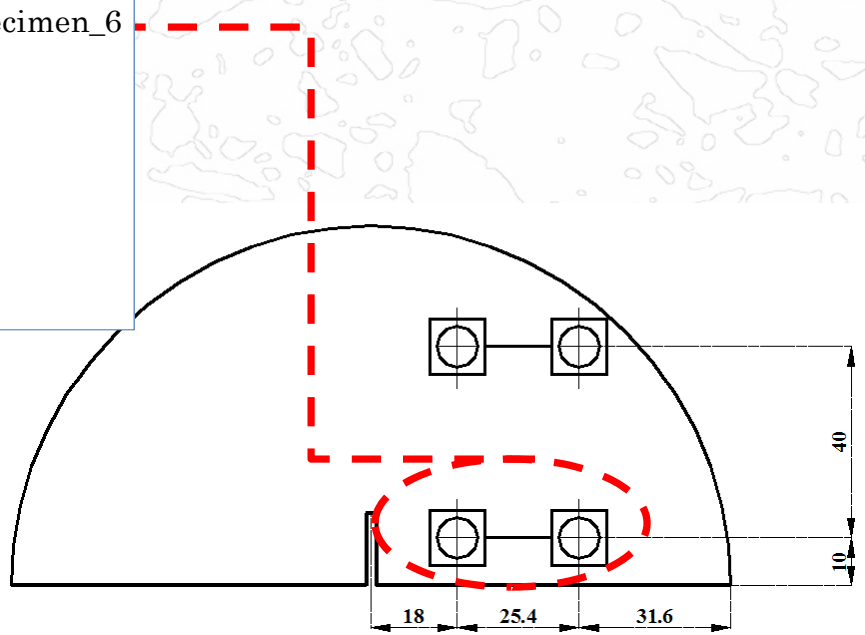


- The contour plot shows
  - High stress concentration regions increase with load
  - For small amount of load the SCB provides elastic regions

SCB stiffness from laboratory experiments



Specimen 5 not convincing!!!!



- **Task 3 – Develop low temperature specification for asphalt mixtures**

  - Subtask 3 – propose simplified method to obtain mixture creep compliance
    - ✓BBR testing of thin asphalt mixture beams
    - ✓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
    - ✓Draft AASHTO specification circulated at ETG
    - ✓Utah DOT implementing testing of small mixture beams as quality control test for low temperature cracking

BBR Fracture Testing

- Promising results with the new proportional valve control allows loading at constant loading rate
- Size effect currently investigated under Idea project

- **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 final validation
- Validation will be based upon testing of the 11 Olmstead County, Minnesota mixes placed in the 2006 construction season

Update:

- All testing completed
- Data analysis in progress

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!