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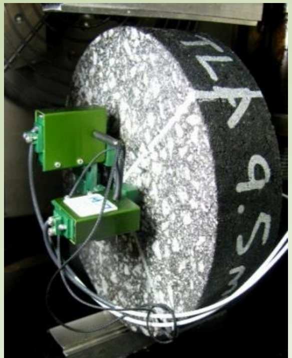
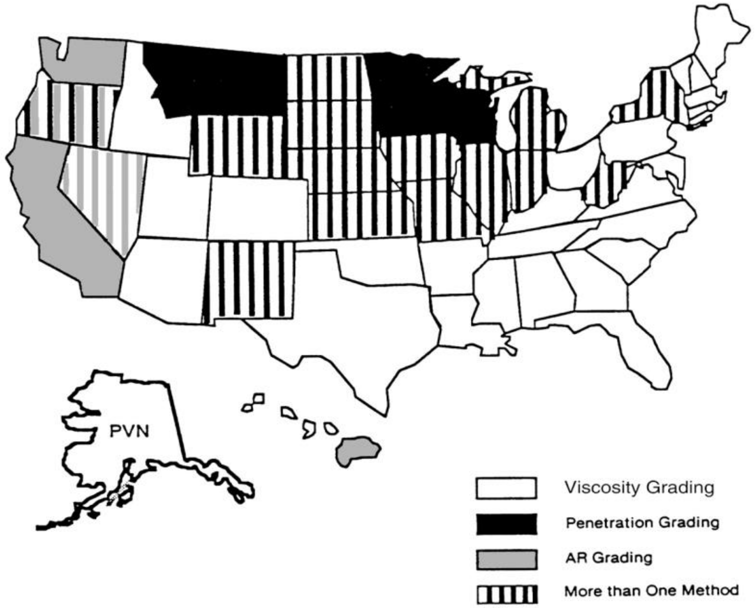
Superpave Performance Graded Binder System



Why Superpave?

- Changes in crude sources,
- Increase in truck traffic,
- Inconsistency in application of binder grading methods throughout U.S.



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Development of Superpave Specifications

- 5 yr $50 million project 1987-1993,
- Goal was to develop new methodologies for specifying, testing, and designing asphalt materials.

Implementation of Superpave PG Binder Specification

- Massive undertaking, required:
  - Learning new test methods,
  - Acquiring new equipment,
  - Re-writing purchase specifications.
- States, contractors, asphalt binder suppliers

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Implementation of Superpave PG Binder Specification

- Accomplished by:
  - Training
  - Information dissemination,
  - Pooled-fund purchases
- Set goal of complete change to Superpave PG Binder Specifications by the end of 1997.

Evolution of Superpave Binder Specifications

- Superpave is constantly evolving
  - Changes in crude sources
  - Changes in modifier types
  - Increased use of recycled materials
  - Development of new testing capabilities

Development of New Test Methods

IDEA
- Research
- Publication

Discussion
- Expert Task Group
- Committee

Proposed Test Method
- Industry
- Voting

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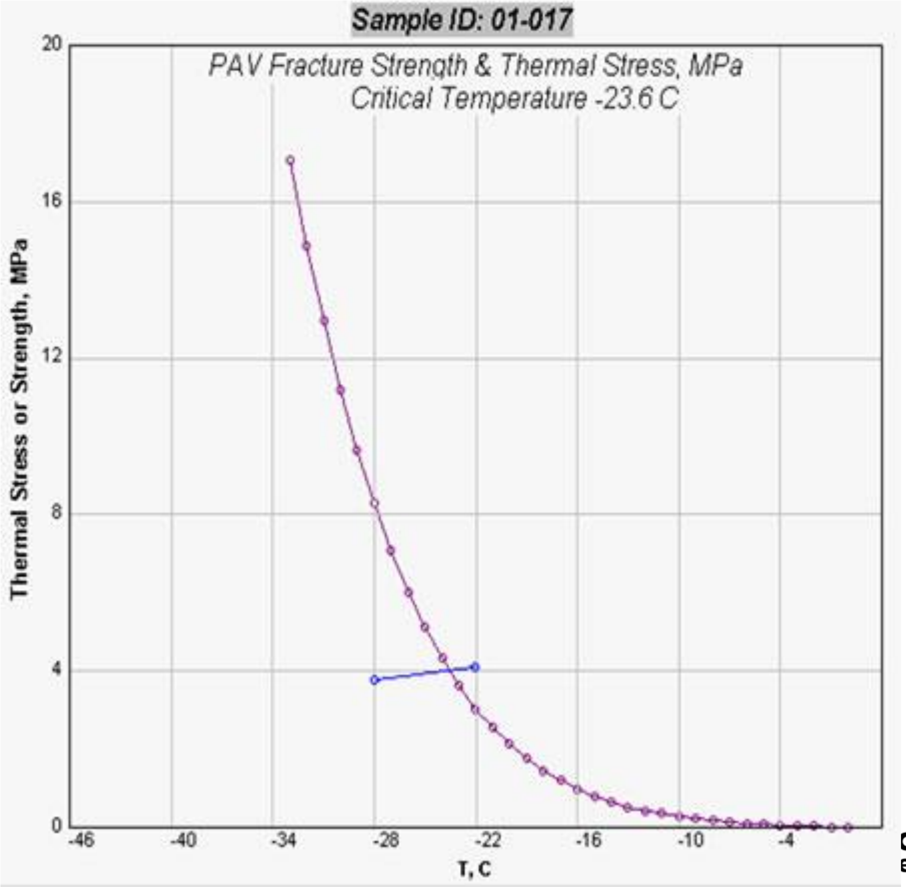
Some Recent Developments in Superpave Binder Testing

- Critical Cracking Temperature
- Asphalt Binder Cracking Device
- 4-mm Dynamic Shear Rheometer
- Glover-Rowe Parameter / Delta Tc
- Single-Edged Notched Bending

Critical Cracking Temperature



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Critical Cracking Temperature

Output: Low temperature grade based on thermal stress curve from Bending Beam Rheometer and failure strength from Direct Tension Test.

Applications: Improved low temperature grade for polymer modified asphalt binders.

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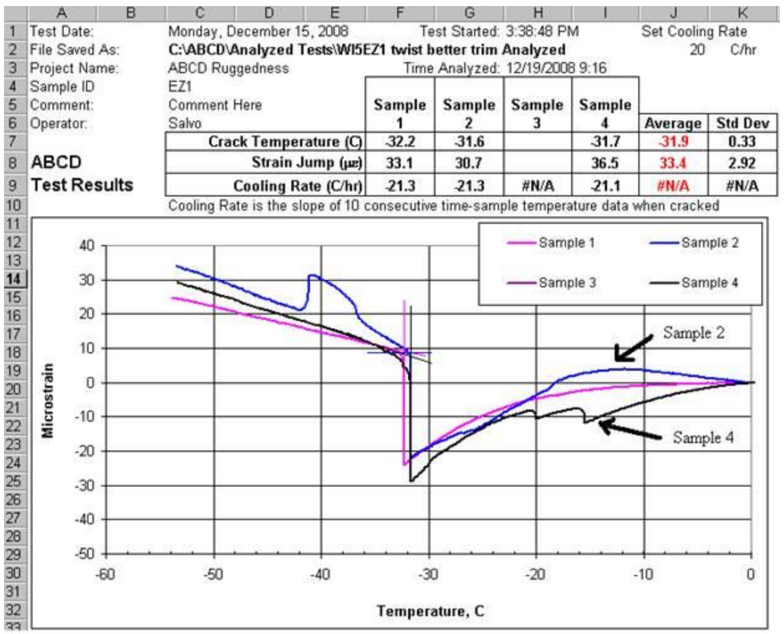
Critical Cracking Temperature

- Repeatability: Poor, highly sensitive to operator error.
- Not widely used in the U.S. for specification purposes, more popular as a research tool.

Asphalt Binder Cracking Device (ABCD)



Test Date:	Monday, December 15, 2008
File Saved As:	C:\ABCD\Analyzed Tests\WI5EZ1 twist better trim Analyzed
Project Name:	ABCD Ruggedness
Sample ID	EZ1
Comment:	Comment Here
Operator:	Salvo

Test Started: 3:38:48 PM

Set Cooling Rate 20 C/hr

Time Analyzed: 12/19/2008 9:16

ABCD Test Results

	Sample 1	Sample 2	Sample 3	Sample 4	Average	Std Dev
Crack Temperature (C)	-32.2	-31.6		-31.7	-31.9	0.33
Strain Jump (με)	33.1	30.7		36.5	33.4	2.92
Cooling Rate (C/hr)	-21.3	-21.3	#N/A	-21.1	#N/A	#N/A

Cooling Rate is the slope of 10 consecutive time-sample temperature data when cracked

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Asphalt Binder Cracking Device

- Output: Low temperature binder grade based on cracking temperature

  Low temp grade = 0.78(crack temp)-0.9

- Applications: Can identify polymer systems that have good low temperature cracking potential but poor results in the bending beam rheometer.

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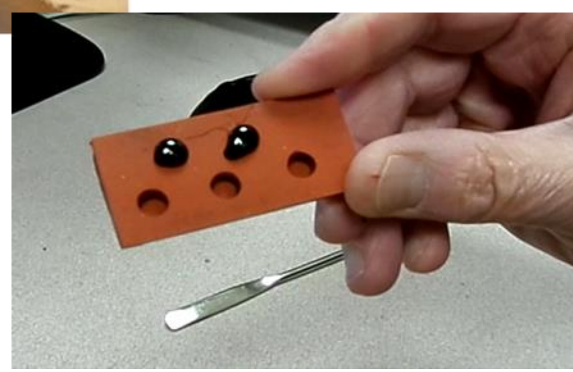
Asphalt Binder Cracking Device

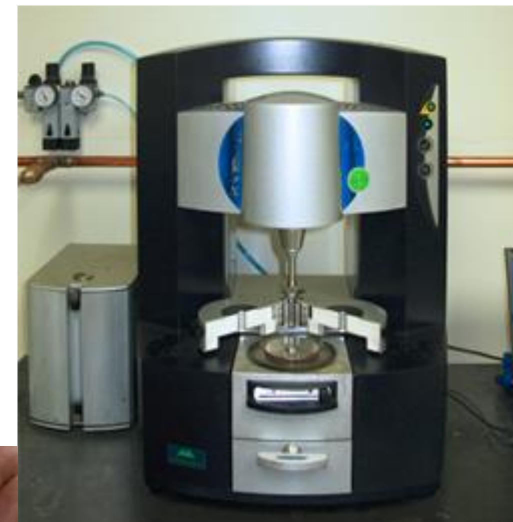
- Repeatability: higher than BBR, but not unacceptable.

- Requires additional equipment purchase.

- AASHTO Provisional Standard TP92

4-mm Dynamic Shear Rheometer





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4-mm Dynamic Shear Rheometer

- Output: Low temperature DSR results that can be used to estimate Bending Beam Rheometer Stiffness and m-value tresults.

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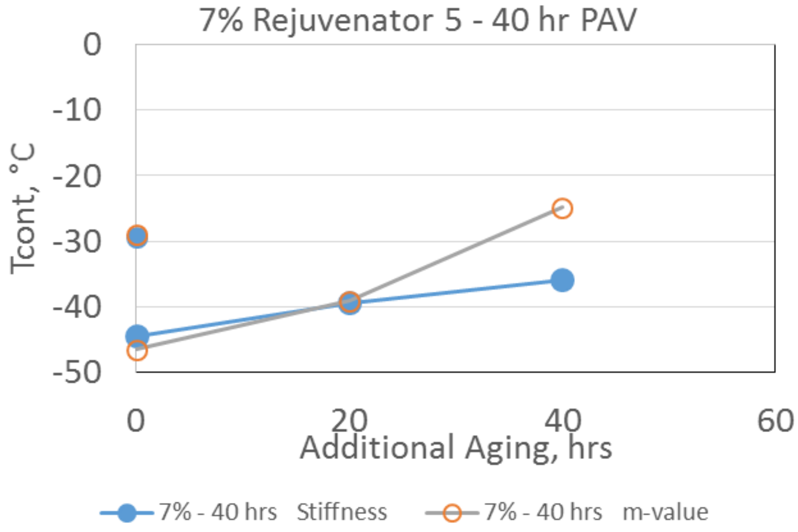
4-mm Dynamic Shear Rheometer

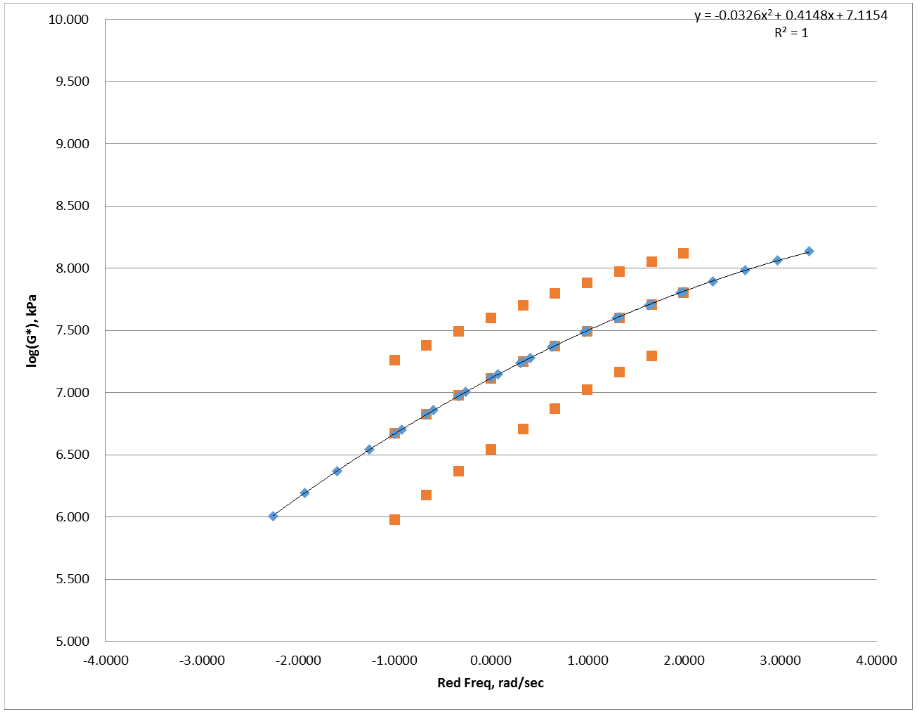
- Applications:
  - Can be used as substitute for BBR,
  - Extremely useful for recovered asphalt binder samples that do not have large quantities of material available,
  - Allows master curve development at low temperatures.

4-mm Dynamic Shear Rheometer

- Repeatability: unknown between labs, needs ruggedness testing to determine.
- Current status: still under development, shows promise as a research tool and potential replacement for BBR.
- Shortcomings: Need a number of labs with proper training before ruggedness / round robin testing can occur.

Glover Rowe / Delta Tc





Glover – Rowe / Delta Tc

- Output: Surrogate parameters for measuring the ductility (or loss thereof) as an asphalt binder ages
- Glover Rowe: Dynamic Shear Rheometer

$$GR = \frac{G^*(cos\delta)^2}{sin\delta}$$

G* and δ at 15 and 0.005 rad/sec

Glover Rowe / Delta Tc

- Delta Tc: Bending Beam Rheometer

$$Tc = BBR\ T_{cont},S - BBR\ T_{cont},m$$

- Applications:
  - Aging behavior of asphalt binders,
  - Effect of recycled materials on asphalt binder properties,
  - Evaluation of modifiers/rejuvenators/ other additives.

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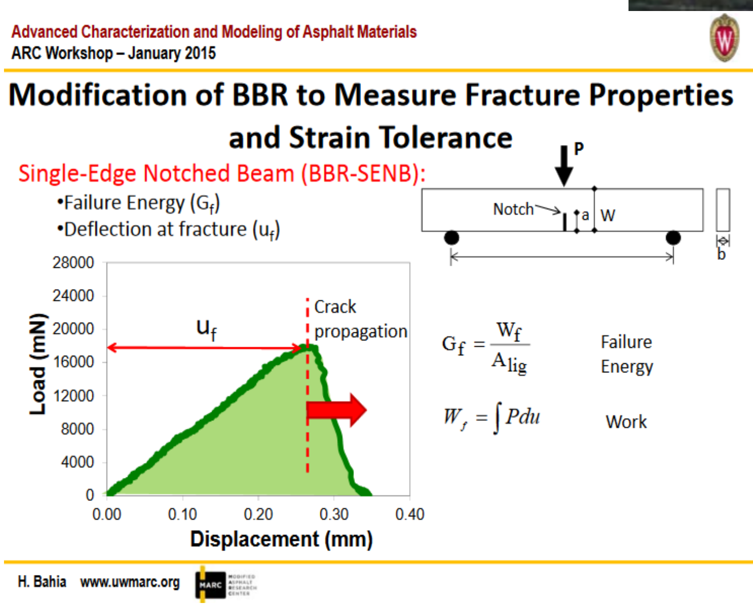
Glover Rowe/Delta Tc

- Repeatability: Uses standard DSR and BBR tests.

Single-Edged Notched Bending (SENB)



Single-Edged Notched Bending

- Output: Fracture energy and deflection at maximum load to characterize thermal cracking at low temperatures..
- Uses standard BBR device modified to include:
  - Loading motor that controls displacement,
  - Load cell with increased capacity,
  - Notch and alignment pins added to standard mold.

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Single-Edged Notched Bending

- Follows ASTM E399,
- Load applied at 0.01 mm/sec deflection until fracture occurs.
- Shows good correlations with laboratory mixture cracking tests and field performance.

Single-Edged Notched Bending

- Applications: Improved characterization for modified asphalt binders with poor BBR performance compared to low temperature fracture resistance.

Closing Remarks

- The Superpave PG Binder Specification is an ever-evolving document.
- Communication between agencies, suppliers, and contractors is crucial for success.
- Developing new test methods is a multi-step process that requires a lot of testing for both laboratory and field validations. Some methods work, some do not.

Questions?

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