Update
NCHRP Project 9-61
Short- and Long-Term Binder Aging Methods to Accurately Reflect Aging in Asphalt Mixtures

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Research Team

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Today's Outline

- Review Objectives and Tasks
- Review Evaluation of Conditioning Procedures
- Planned Experimental Work
- Schedule

Objectives

- Evaluate laboratory conditioning procedures
  - AASHTO T 240, AASHTO R 28 and alternatives
- Recommend improvements
  - New procedure
  - Modifications to existing procedures
- Calibrate the improved procedures to accurately simulate aging
  - Mixture production, transport, and placement
  - Service life of the pavement

Approach

- Task 1. Evaluate and Select Methods
- Task 2. Prepare Experimental Plans
- Task 3. Prepare Interim Report
- Task 4. Conduct and Analyze Experiments
- Task 5. Perform Industry Impact Assessment
- Task 6. Prepare Methods in AASHTO Format
- Task 7. Prepare Final Report

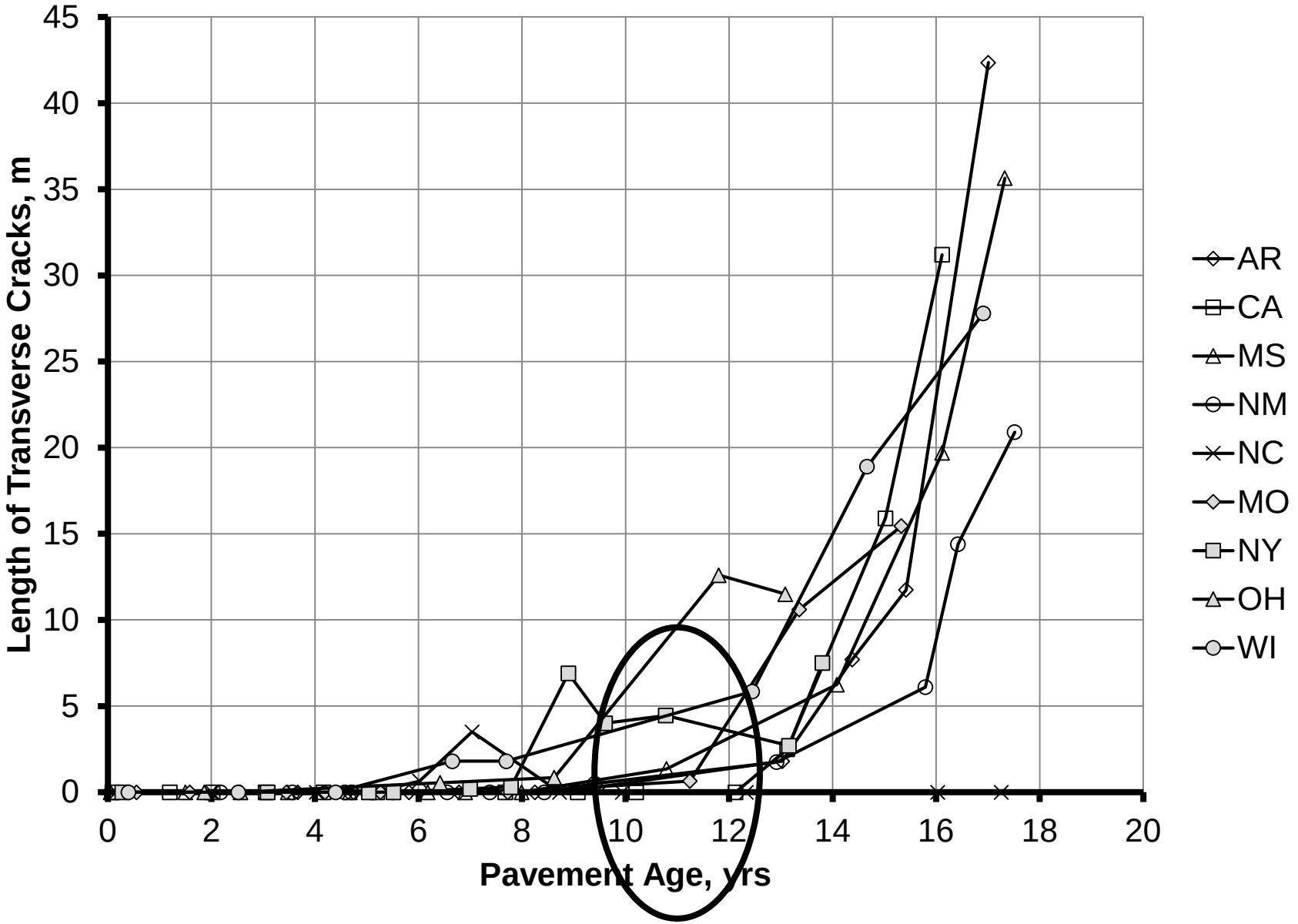
Guiding Principles

- Binder aging is a two stage process
  - Short-Term or Construction
    - High temperature
    - Oxidation and volatile loss
  - Long-Term or Service life
    - Service temperature
    - Oxidation
  - Laboratory conditioning needs to address both
    - Short-term at typical construction temperatures
    - Long-term requires a compromise to accelerate the process

Guiding Principles

- Conditioning procedures must yield enough binder for current specification testing
  - 4 mm DSR is an excellent tool for research and forensic evaluation but it is not ready for use in practice
- Conditioning procedures need to be calibrated to pavements

Transverse Cracking in SPS 8 Sections



Practice Related Conditioning Issues

AASHTO T 240 (RTFOT)

- Uniformity of the film
- Some modified binders tend to crawl out of the bottle
- Shape of the bottle makes recovery of the binder and cleaning difficult
- Procedure does not address WMA

AASHTO R 28 (PAV)

- Concern that conditioning is not severe enough
- Service life that is simulated is not well defined

Alternatives Considered

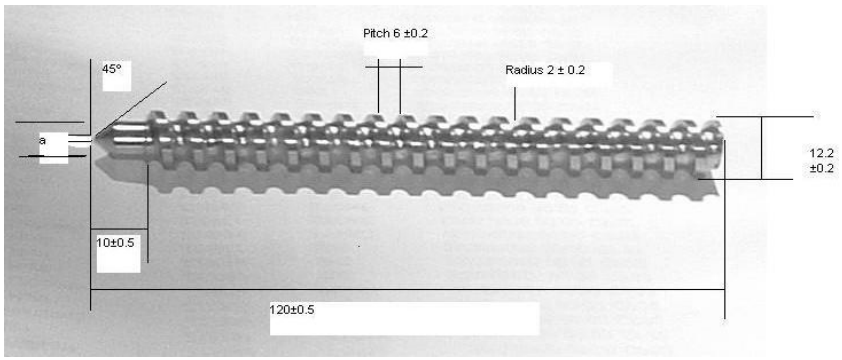
Procedure	Short-Term	Long-Term
Ageing Profile Test (UK)	X	X
Modified German Rotating Flask	X	
PAV Modifications • Film Thickness • Time • Temperature • Pressure • Mixing (Ultrasonic or Acoustic)		X
Rotating Cylinder Ageing Test	X	X
Stirred Air Flow Test	X	
Universal Simple Aging Test (USAT)	X	X

Evaluation Criteria

- Address issues with current procedures
- Quantity of binder
- Number of binders per run
- Conditioning time
- Field calibration
- Standardization
- Equipment availability and cost
- Training effort and cost

Short-Term Selections

- Modifications to AASHTO T 240 made in the U.K. Ageing Profile Test

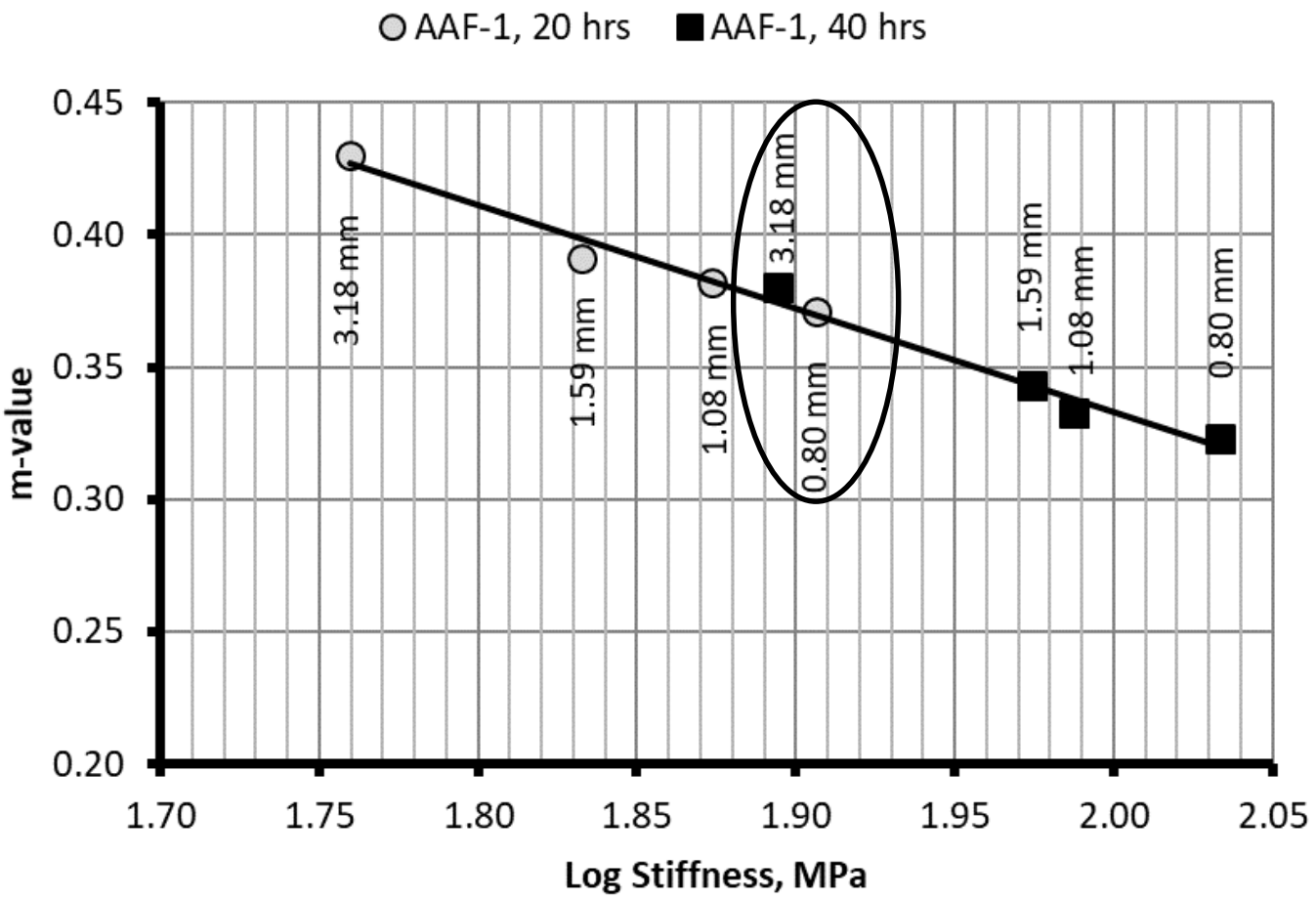


- Thicker Film USAT
  - Around 0.8 mm rather than 0.3 mm to increase yield

Long-Term Selection

- PAV Optimization
  - Thinner film
  - Longer condition times
  - Increased temperatures
  - Ruled Out
    - Increased pressure
      - Current vessel design
      - Shape of pressure dependency of oxidation reactions
    - Ultrasonic or Acoustic Mixing
      - Not successful in preliminary testing

PAV Film Thickness



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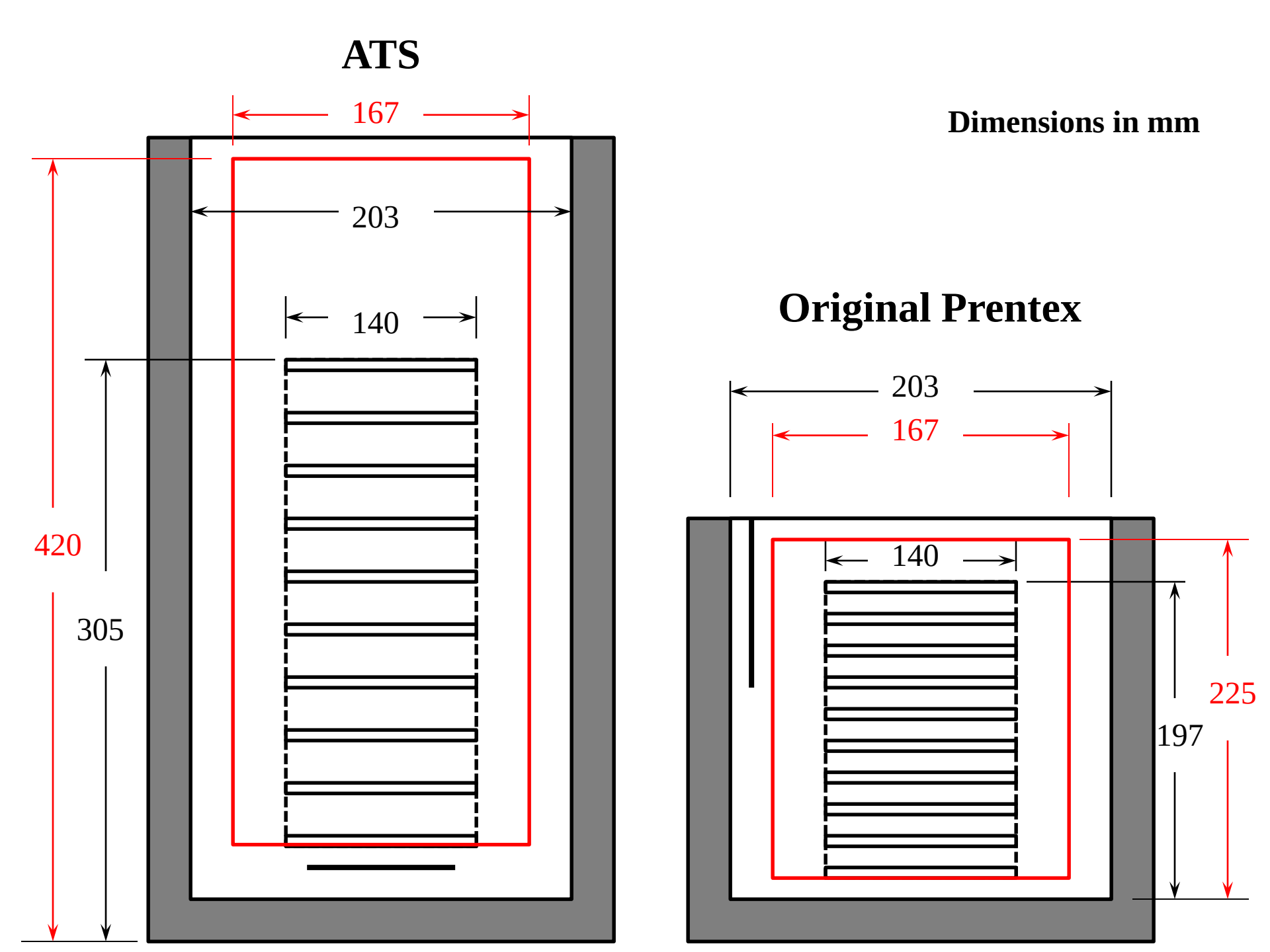

ATS
167
203
140
420
305
Dimensions in mm
Original Prentex
203
167
140
225
197

Phase 2 Experiments

- Short-Term
  - Selection
  - Calibration
- Long-Term
  - PAV Operating Parameters
  - Calibration
- Sensitivity Study

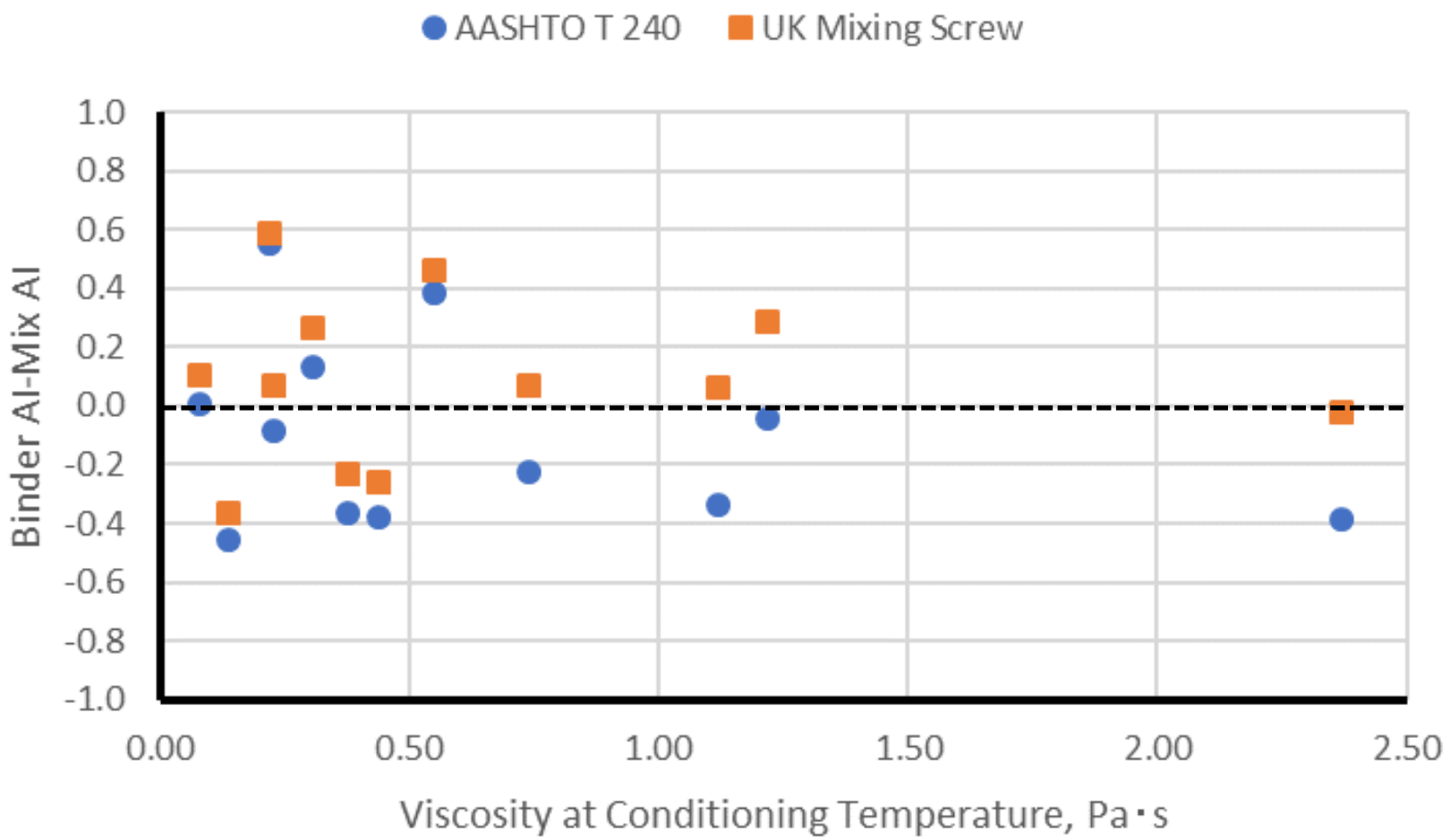
Short-Term Selection

- Make final selection of short-term procedure
  - AASHTO T 240
  - AASHTO T 240 with mixing screw
  - Static thin film (0.8 mm)
- Compare binder conditioning procedures to binder recovered from short-term oven conditioned mixtures
  - NCHRP 9-52 recommendations
    - HMA 2 hours at 135 °C
    - WMA 2 hours at 116 °C

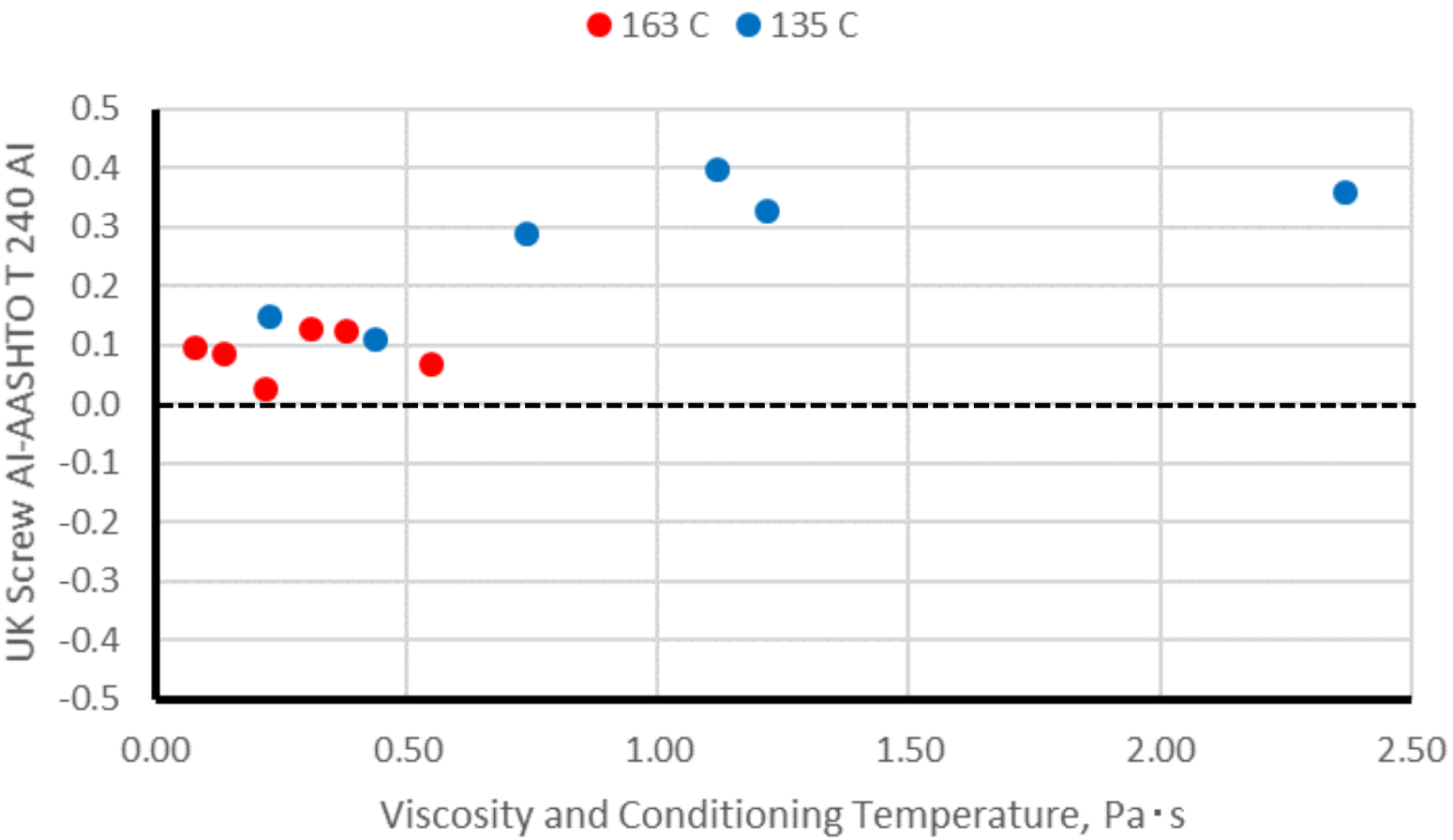
Short-Term Selection Binders

Binder	Viscosity Pa·s	
	135 C	163 C
Neat PG 52-34	0.22	0.07
Terpolymer PG 64-34	0.73	0.21
Neat PG 64-22	0.43	0.13
SBS PG 76-22	1.11	0.30
SBS PG 64-34	1.21	0.37
SBS PG 76-28	2.36	0.54

Initial Results



Initial Results



Short-Term Calibration

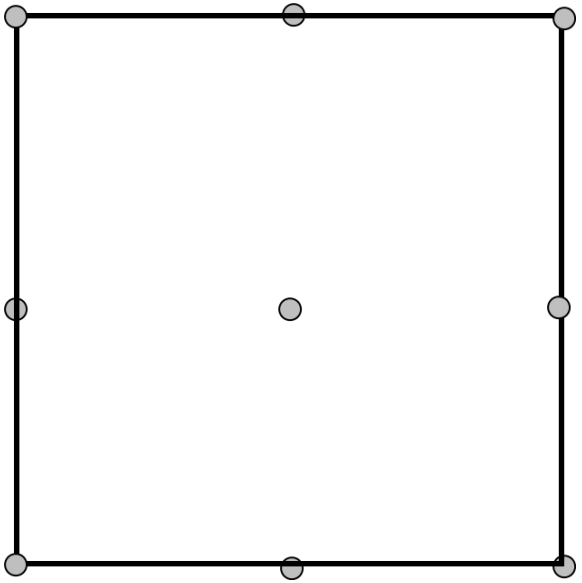
- Calibrate the selected procedure (varying conditioning time) to reproduce properties of binder recovered from short-term conditioned loose mix
- NCHRP 9-52 recommendations
  - HMA 2 hours at 135 °C
  - WMA 2 hours at 116 °C

PAV Operating Parameters

- Investigate how to reasonably simulate more aging using the PAV
- Vary
  - Thickness: 1.59 mm to 0.8 mm
  - Time: 20 to 40 hours
  - Temperature: 100 to 120 ºC
- Compare to recovered binders
  - Hot Climate ARC Arizona Validation (4 & 9 yrs)
  - Cool Climate ARC Minnesota Validation (5 &11 yrs)
  - 3 depths

Factorial Design

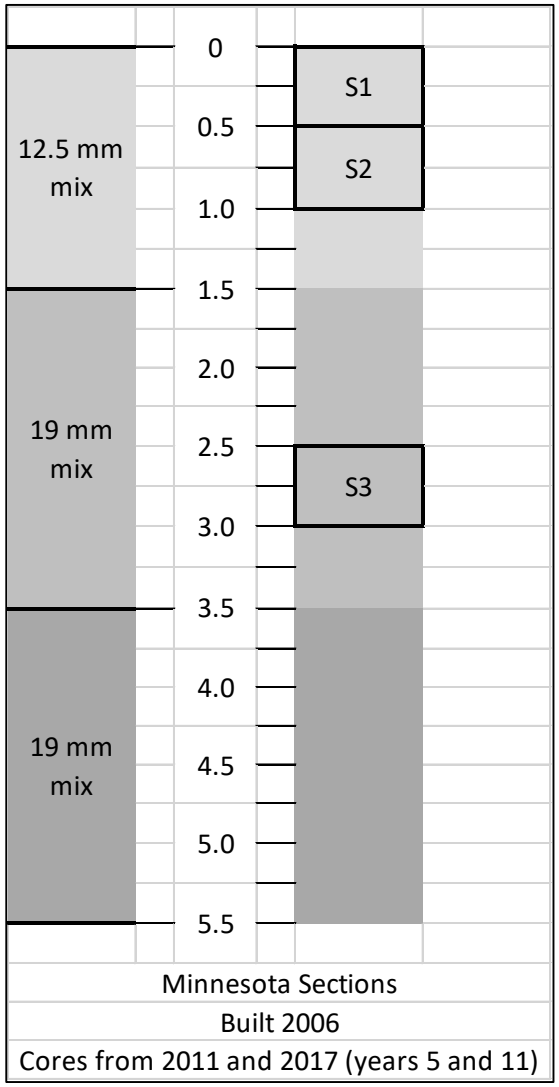
Run	Temp., °C	Mass, g	Time, hrs
1	100	12.5	20
2	120	12.5	20
3	100	25.0	20
4	120	25.0	20
5	100	12.5	40
6	120	12.5	40
7	100	25.0	40
8	120	25.0	40
9	100	18.8	30
10	120	18.8	30
11	110	12.5	30
12	110	25.0	30
13	110	18.8	20
14	110	18.8	40
15	110	18.8	30
16	110	18.8	30
17	110	18.8	30
18	110	18.8	30
19	110	18.8	30
20	110	18.8	30



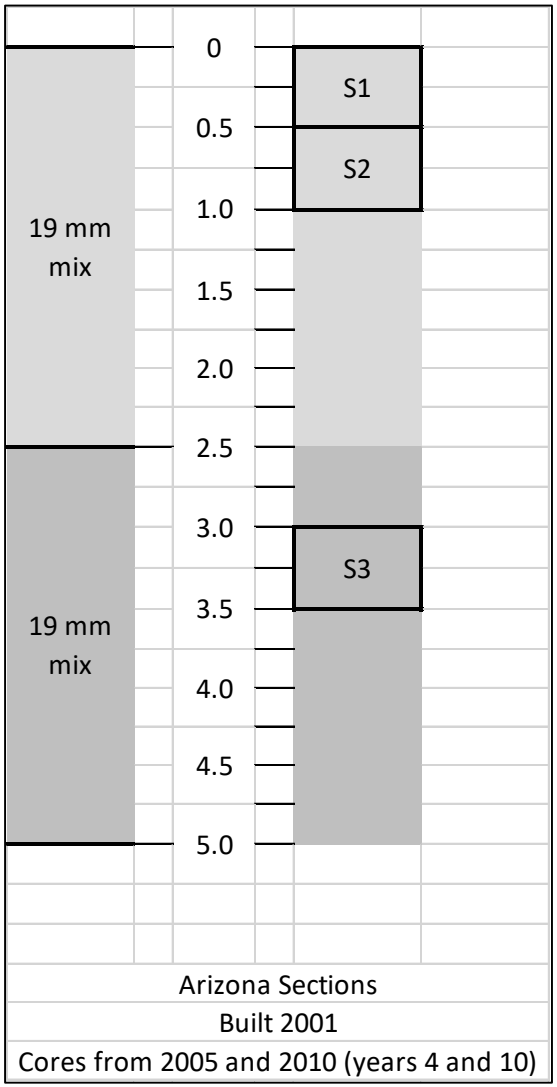
ARC AZ and MN Binders

Site	Grade	Source	Modification
Arizona US 93	PG 76-16	WTI/WTS blend	Airblown
	PG 76-16	Venezuelan	N/A
	PG 76-16	Rocky Mountain Blend	N/A
	PG 76-16	Canadian Blend	N/A
Rochester, MN	PG 58-34	Canadian Blend	Terpolymer
	PG 58-28	Canadian Blend	N/A
	PG 58-28	Middle East Blend	N/A
	PG 58-28	Venezuelan Blend	N/A

Recovered Binder Locations



Minnesota Sections
Built 2006
Cores from 2011 and 2017 (years 5 and 11)



Arizona Sections
Built 2001
Cores from 2005 and 2010 (years 4 and 10)

Long-Term Calibration Using Original Binders and Cores From LTPP

30 Pavements
Age: 8 to 19 yrs
Degree Days: 1400 to 5800

Sensitivity Study

- AASHTO M 320 Table 1 and AASHTO M 332 grade several binders
  - Current AASHTO T 240 and AASHTO R 28
  - Improved procedures developed in NCHRP 9-61
  - Materials with proven performance
  - Newer materials
  - 10 binders
- Information for the Industry Assessment

Status

- Phase 1 complete
  - Interim report available from NCHRP
- In-Progress
  - Short-Term Selection Experiment
  - PAV Operating Parameters Experiment
- Panel review prior to calibration this summer
- Project completion date August 31, 2019

Questions/Discussion

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