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Long-term Oven Aging Protocols for Cracking Performance Evaluation of Asphalt Mixtures in Virginia

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Virginia Asphalt Association – Mid-Atlantic Asphalt Expo

Wednesday December 6th, 2023, Richmond, VA

Research Team

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Background

- Laboratory testing of asphalt mixtures
  - Ensure asphalt mixtures meet specified quality and performance
- Laboratory testing procedures involve conditioning
  - Short-term mixture oven conditioning (aging) – pre-compaction
    - Allow for binder absorption during the mix design and simulate plant mixing
      - Volumetric mixture design
      - Mechanical property (performance) testing
  - Long-term mixture oven conditioning (aging) – post-compaction
    - Simulate aging of asphalt mixtures in service – anywhere from 1 to ? years
      - Mechanical property (performance) testing

Background

BMD Performance Tests & Criteria

❑ A and D surface mixtures with 9.5mm and 12.5mm NMAS

➢ Testing on specimens from <u>short-term oven aged</u> mixtures only

Durability

Cantabro Test

CML ≤ 7.5 %

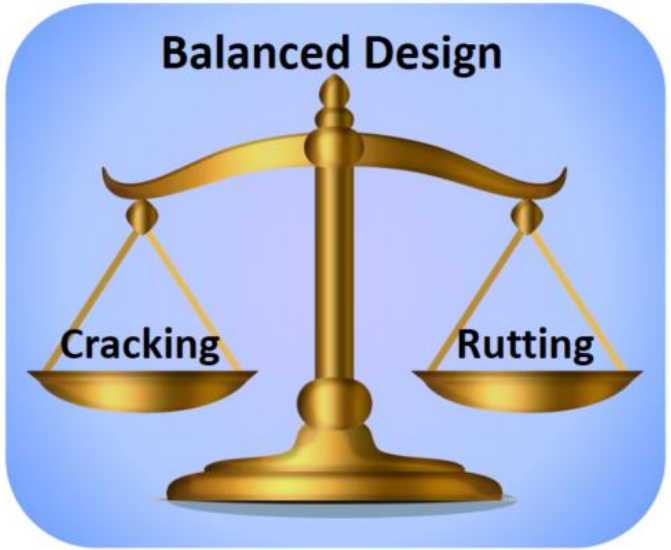
Rutting

Asphalt Pavement Analyzer Test

RD ≤ 8.0 mm

IDT-HT Test

Wet Strength ≥ 100 kPa



Cracking

Indirect Tensile Cracking Test

CT index ≥ 70 (reheats)

CT index ≥ 95 (non-reheats)

Moisture Damage

Tensile Strength Ratio Test

TSR ≥ 80 %

Background
Long-term Oven Aging Protocols

- AASHTO R30
  - Oven aging of compacted specimens at **85°C** for 5 days
    - A single prescription for all conditions
    - Aging gradient – increased variability for laboratory testing
    - Specimen integrity problems
    - Practicality

Background
Long-term Oven Aging Protocols

- NCHRP Project 09-54
  - Oven aging of loose asphalt mixture specimens at **95ºC** at climate-dependent oven-aging durations to match 4, 8, and 16 years of field aging at depths of 6 mm, 20 mm, and 50 mm below the pavement surface.
    - Overestimation for the mixtures with high recycled/modified components
    - Practicality (in some cases)

Background

Long-term Oven Aging Protocols

- NCHRP 09-54 for Virginia - Targeting **8** Years of Field Aging

Virginia Aging Boundary	Below Surface	6 mm	20 mm	50 mm
	Field Aging (Years)	Oven Aging at 95°C (Days)	Oven Aging at 95°C (Days)	Oven Aging at 95°C (Days)
Min	4	2	1	1
	8	5	2	1
	16	10	4	2
Max	4	4	2	1
	8	8	4	2
	16	17	8	5

Background
Long-term Oven Aging Protocols

- Elevated Temperatures
  - Oven aging of loose asphalt mixture specimens at elevated temperatures (e.g., 120ºC, 135ºC, and compaction temperature)
    - Potential issues with certain binders
    - Potential issues with “long” aging durations

Background

Long-term Oven Aging Protocols

- Elevated Temperatures

Virginia Aging Boundary	Below Surface	6 mm		20 mm		50 mm	
	Field Aging (Years)	Oven Aging at 95°C (Days)	Oven Aging at 135°C (Hours)	Oven Aging at 95°C (Days)	Oven Aging at 135°C (Hours)	Oven Aging at 95°C (Days)	Oven Aging at 135°C (Hours)
Min	4	2	5.8	1	3.8	1	3.8
	8	5	**11.8**	2	5.8	1	3.8
	16	10	**21.9**	4	9.8	2	5.8
Max	4	4	9.8	2	5.8	1	3.8
	8	8	**17.9**	4	9.8	2	5.8
	16	17	**35.9**	8	**17.9**	5	**11.8**

Background

Important Note

- Short-term oven aging – different procedures
  - 2 hours at 116ºC for WMA and 135ºC for HMA (AASHTO R30)
  - 2 hours or 4 hours at compaction temperature (VDOT)
    - APA/IDT-HT/Cantabro/Volumetrics: 2 hours at compaction temperature
    - IDT-CT: 4 hours at compaction temperature
  - No short-term oven aging for plant-produced mixtures
- Long-term oven aging preceded by short-term oven aging
  - No short-term oven aging for plant-produced mixtures

Objectives

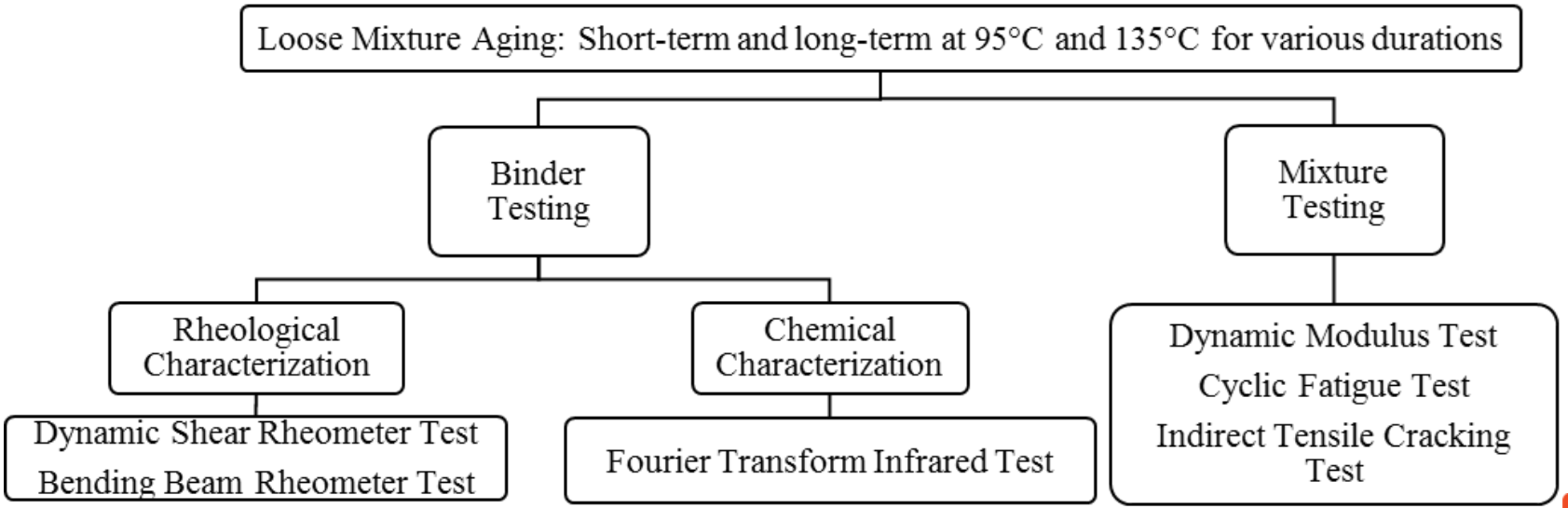
- Develop practical long-term oven aging protocols for BMD mixes that can be used in mix design verification and production of asphalt mixtures for quality control and acceptance purposes
- Develop preliminary performance criteria for CT index for the to-be-developed long-term aging protocols

Wait! Why is this just for IDT-CT, but not for other tests?

Scope

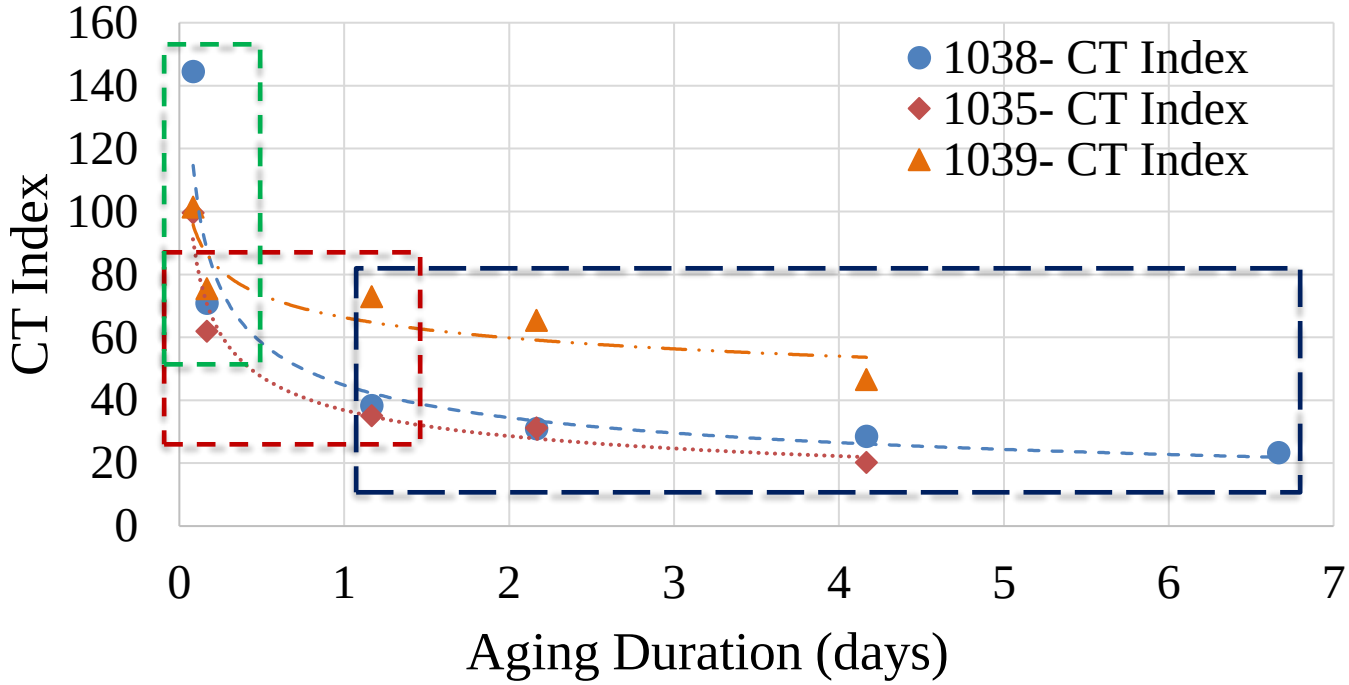
Compaction Temperature!

- 10 different plant-produced mixtures and raw materials
- Field cores from 2015 sections



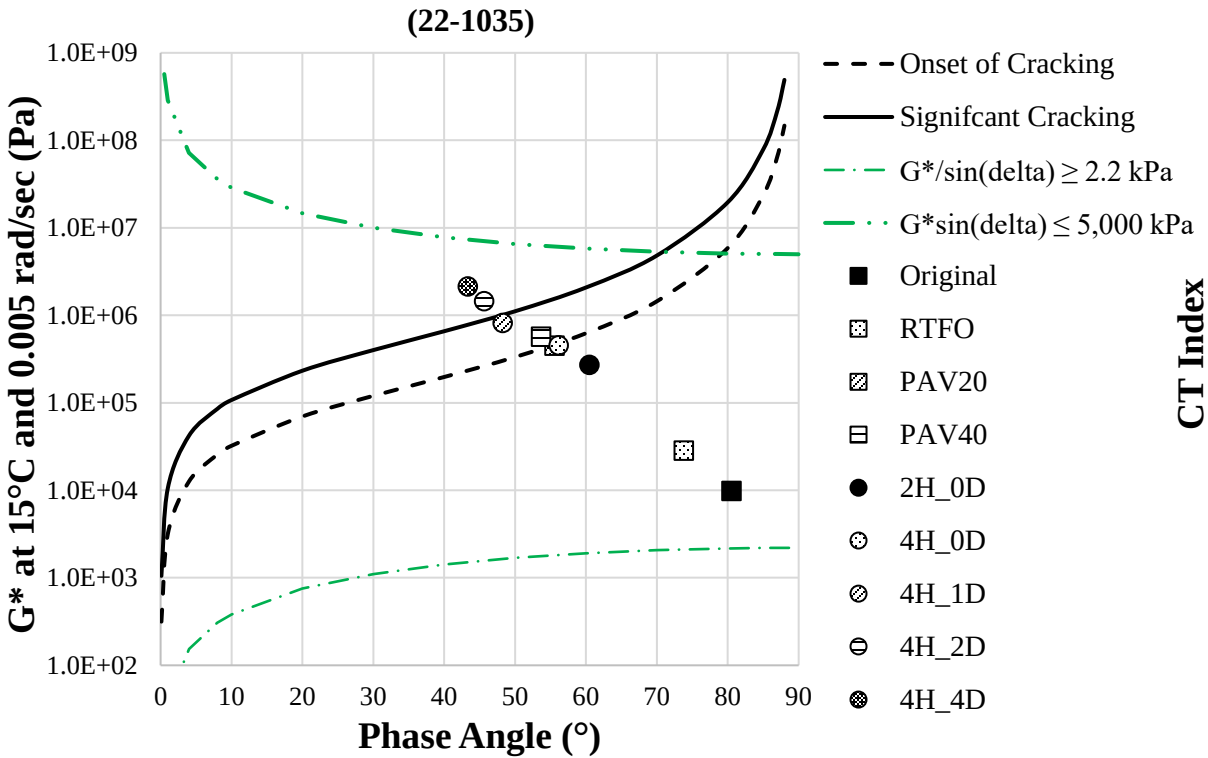
Results: IDT-CT Testing

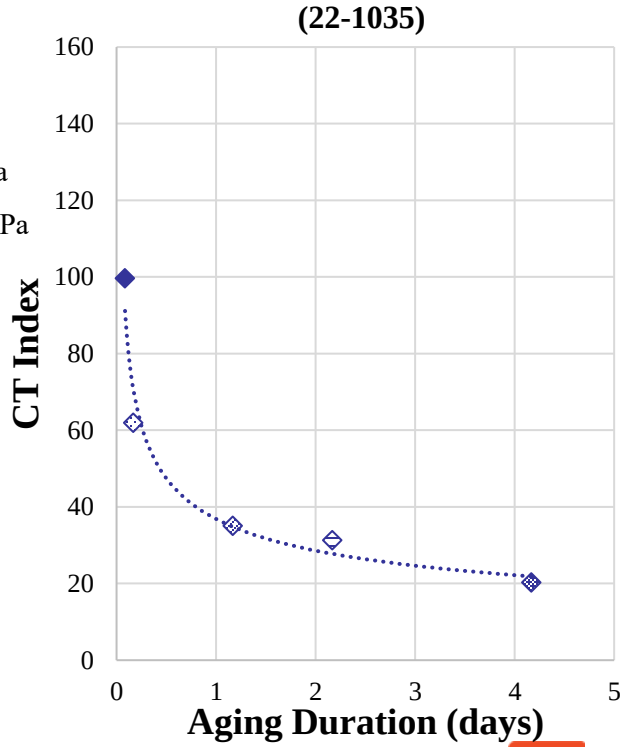
- Long-term aging at 95ºC (after 4 hours at compaction temperature)



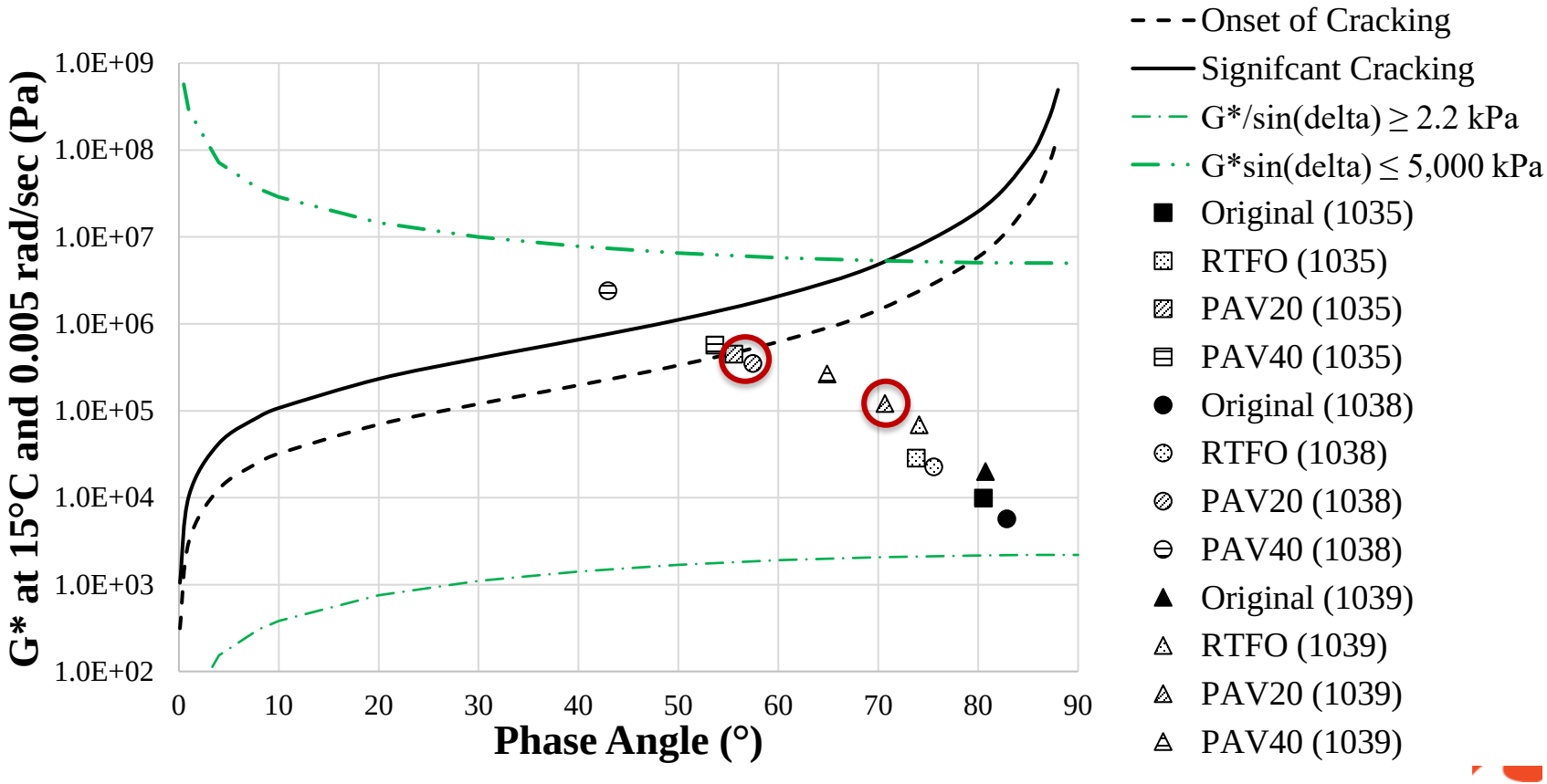
$$\text{G-R}= \frac{G^*(cos\partial)^2}{sin\partial}$$

Results: Example Data

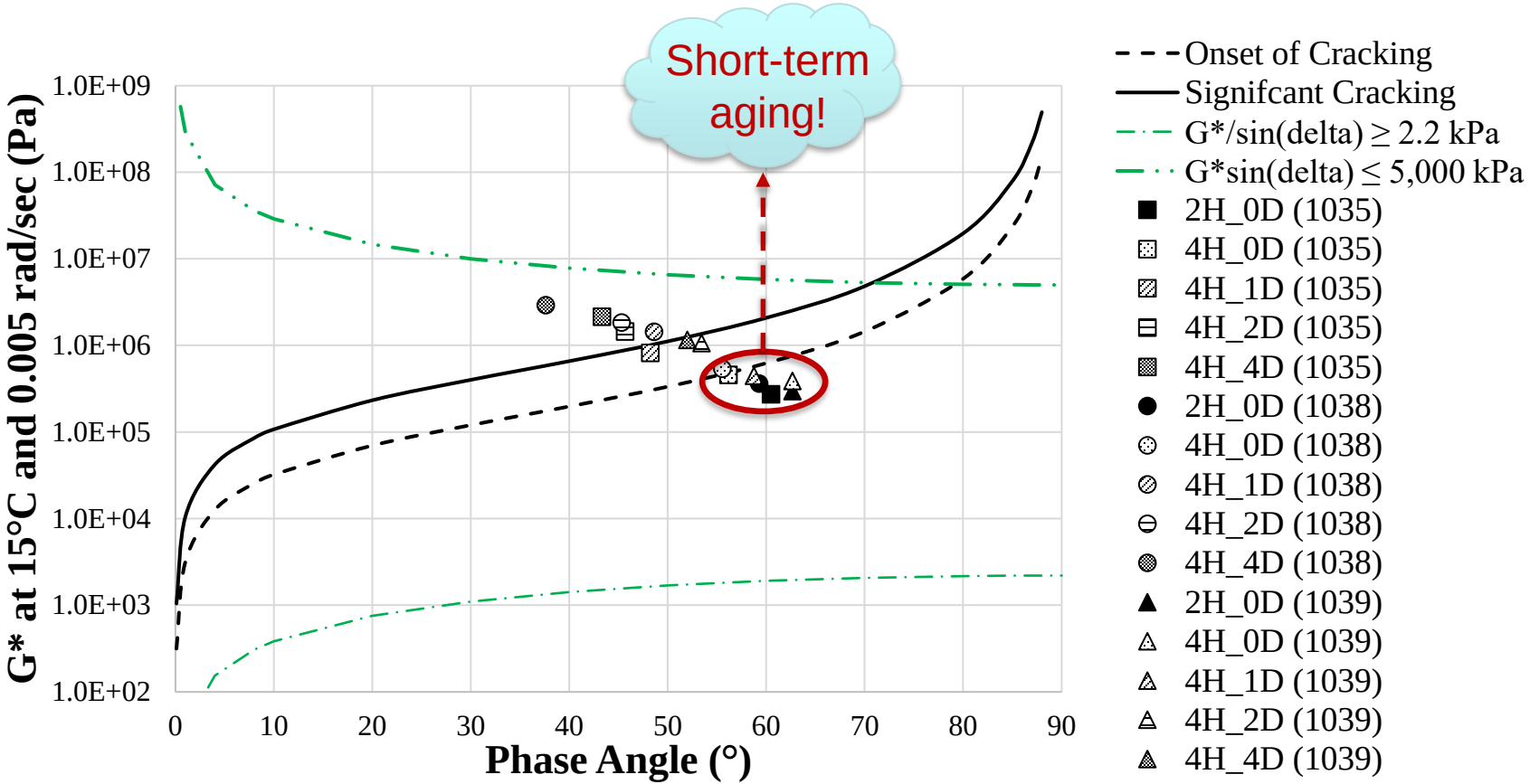




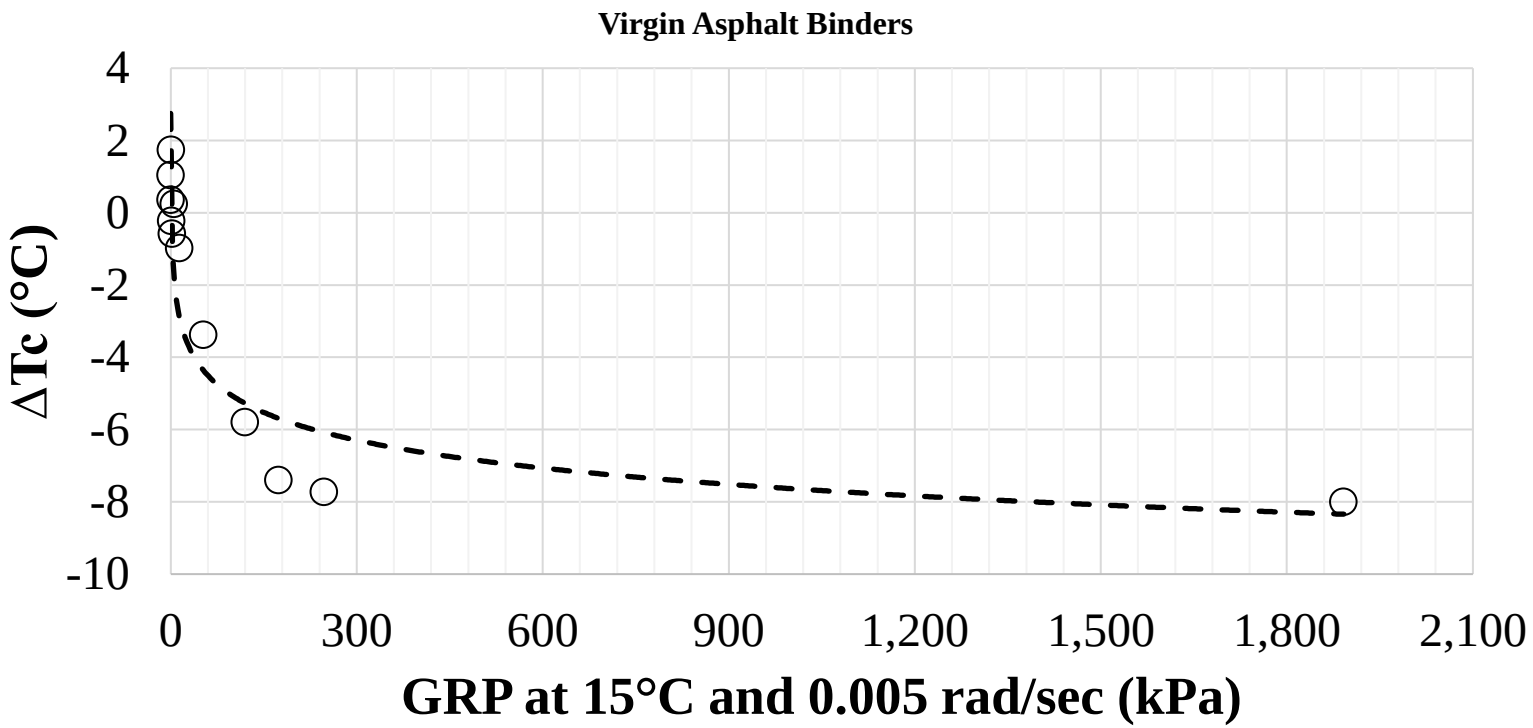
Results: Virgin Binders



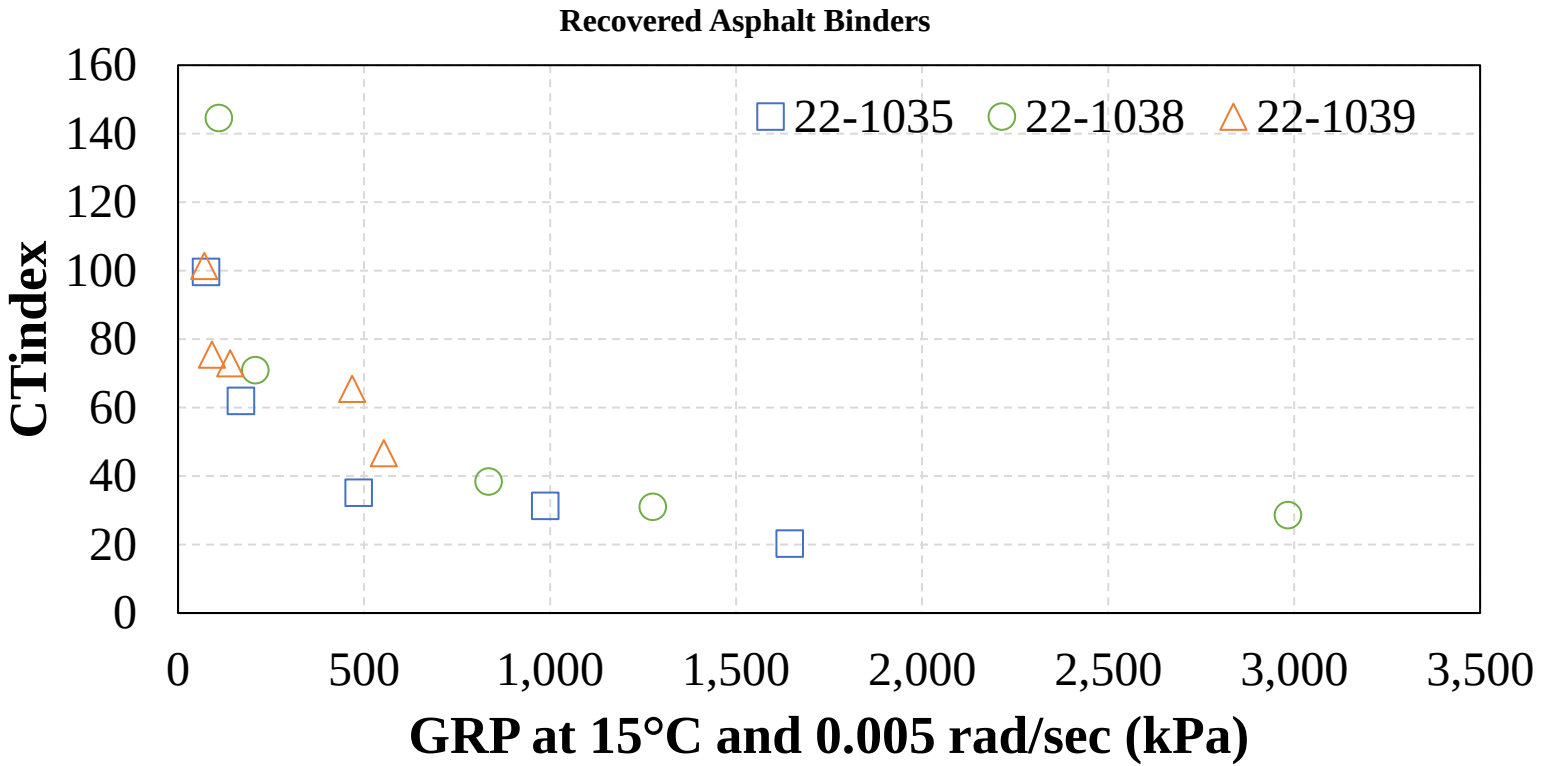
Results: Recovered Binders



Results: G-R vs Delta Tc

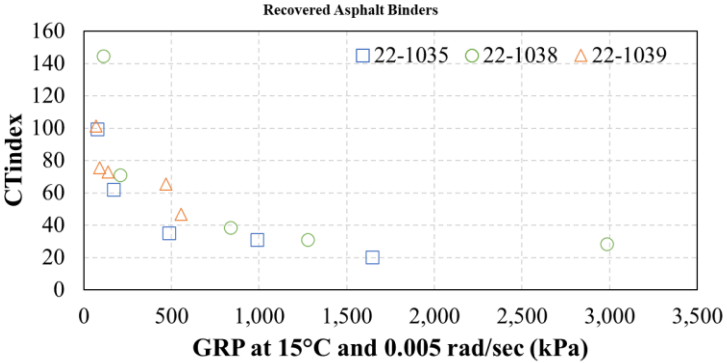


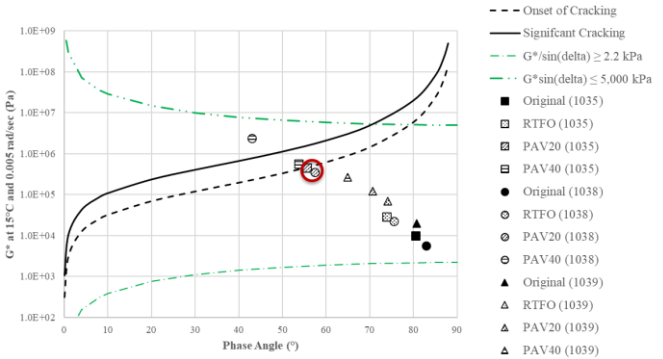
Results: G-R vs CT Index



Findings

Recovered		
	Onset of Cracking	**Significant Cracking**
22-1035	4H_0D	4H_1D
22-1038	4H_0D	4H_1D
22-1039	4H_1D	4H_2D
Virgin		
22-1035	PAV 20	-
22-1038	PAV 20	PAV 40
22-1039	-	-





- **For CT index of 71.04 (GRP of 180 kPa): Duration=0.26 days**
- **For CT index of 42.8 (GRP of 600 kPa): Duration=1.41 days**

Work in Progress

- Verify the findings with additional data
- Identify equivalent aging conditions at elevated temperatures (i.e., 135ºC and/or compaction temperature)
- Perform fundamental tests
- Perform Mechanistic-Empiric analyses
- Correlate laboratory aging to field aging (field cores)

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Thank You!
Questions?

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