Long-term Testing and Analysis on Asphalt Mix Rejuvenator Field Sections

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Project Update Meeting
November 19, 2020

University of New Hampshire

NRRA National Road Research Alliance

MTE Mathy Technology and Engineering Services

Study Motivation and Objectives

- Rejuvenators used to incorporate higher amounts of RAP
- Very little long-term performance information (lab or field)
- Some concerns with extent of effectiveness over time
- Field test sections in Emily, MN constructed in August 2019
  - Wearing course with 40% RAP
  - Seven different RA products to meet PG XX-34 target for extracted & recovered binder
  - Control mixtures with 40% RAP and 30% RAP
- Evaluate effectiveness of the seven RA products placed in the test sections over time
- Compare performance to control sections

Field Test Sections

- Cell 6001 – RA1
- Cell 6002 – RA2
- Cell 6003 – RA3
- Cell 6004 – RA4
- Cell 6005 – RA5
- Cell 6006 – RA6
- Cell 6007 – RA7
- Cell 6010 – 30% RAP control, 30% RAP
- Cell 6011 – 40% RAP control (day 1), 40% RAP1
- Cell 6012 – 40% RAP control (day 2), 40% RAP2

Research Approach

- Binder and mixture characterization and performance testing to capture:
  - physical-mechanical properties of the asphalt binders over time
  - chemical properties of the asphalt binders over time
  - mechanical properties of the mixtures over time
- Various laboratory aging levels
- Testing of field cores
- Field performance of test sections over time

Project Tasks

1. **Literature Review and Monitoring Coordination**
2. Annual Interim Update 1st Year - Initial Construction Results
3. Plant Produced Mixture and Field Core Testing
4. Binder Testing
5. Annual Interim Update 2nd and 3rd Year
6. Final Report

Project Schedule

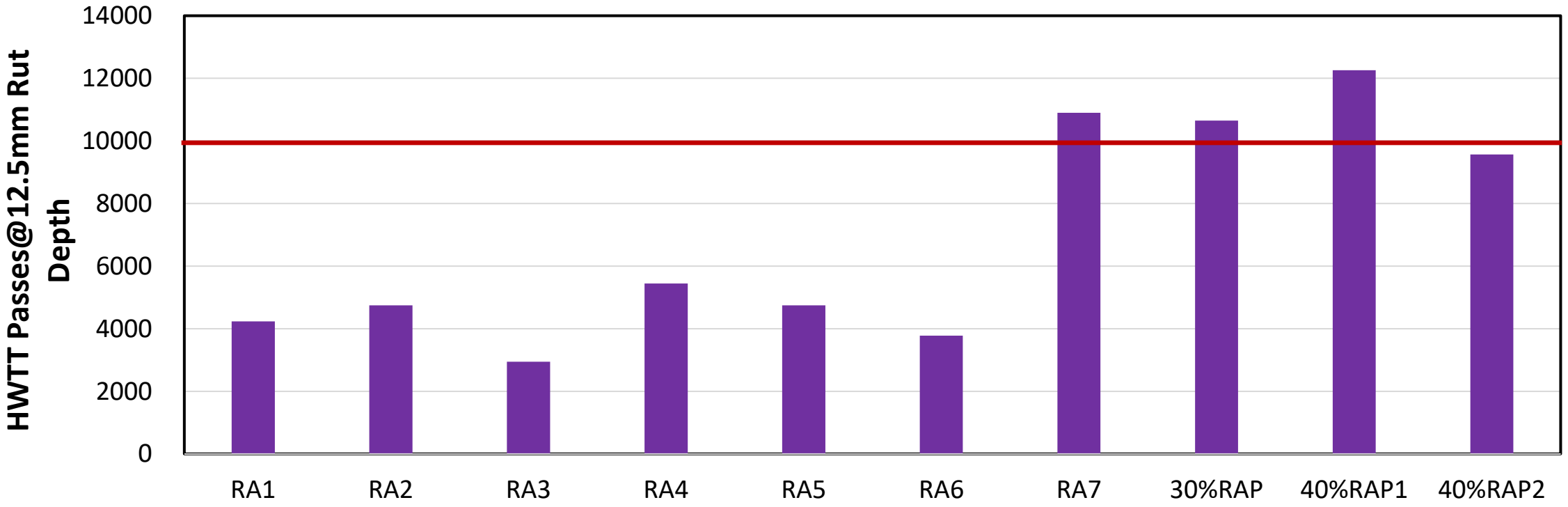
Year	2020				2021							
Month	S	O	N	D	J	F	M	A	M	J	J	A
Task 1: Workplan finalize												
Task 2: Construction Results												
Task 3: Mixture testing												
Task 4: Binder testing												
Task 5: Summary Reports												
Task 6: Final Report												
Reports						Task 1						Task 2
TAP meetings/presentations												

- Year 2: binder and mixture testing, Task 3, 4 & 5 reports
- Years 3&4: binder and mixture testing, Task 5 & 6 reports

Mixture Testing Data (Received to Date)

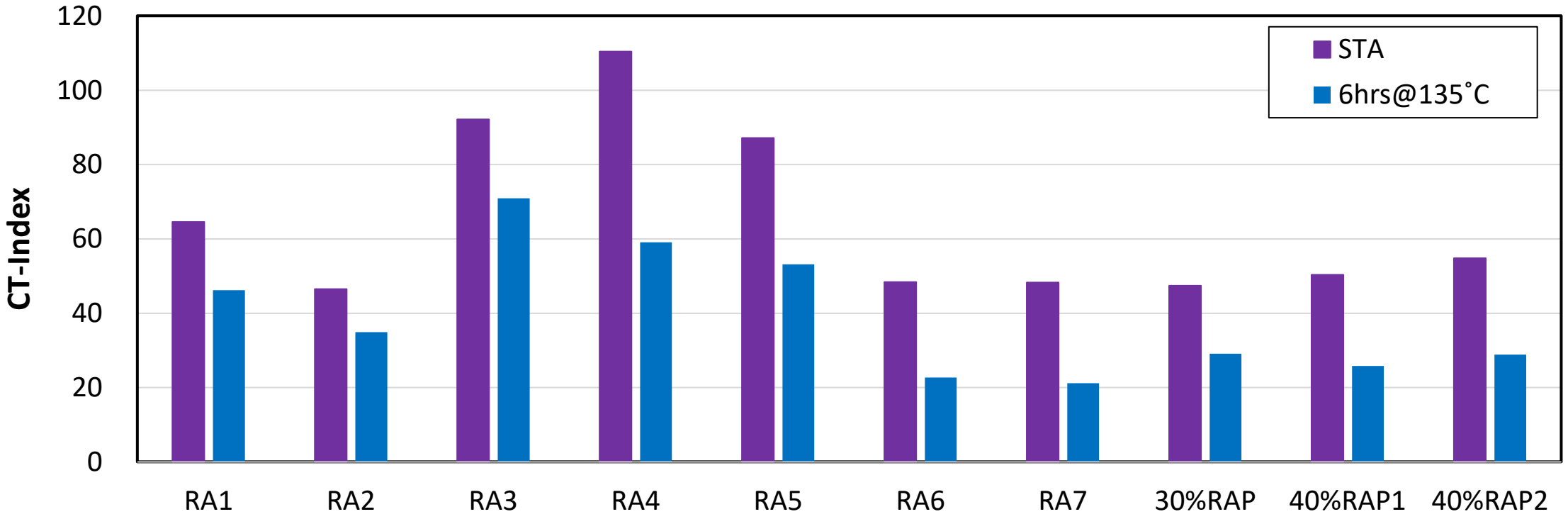
- Hamburg Wheel Track Test (MnDOT)
  - Plant mix
- CT-Index (WisDOT)
  - Plant mix
  - 6 hours@135˚C
- Flexibility Index (IDOT)
  - Plant mix
  - 6 hours@135˚C
  - 3 days@95˚C (compacted specimen)

Hamburg Wheel Track Test (MnDOT)



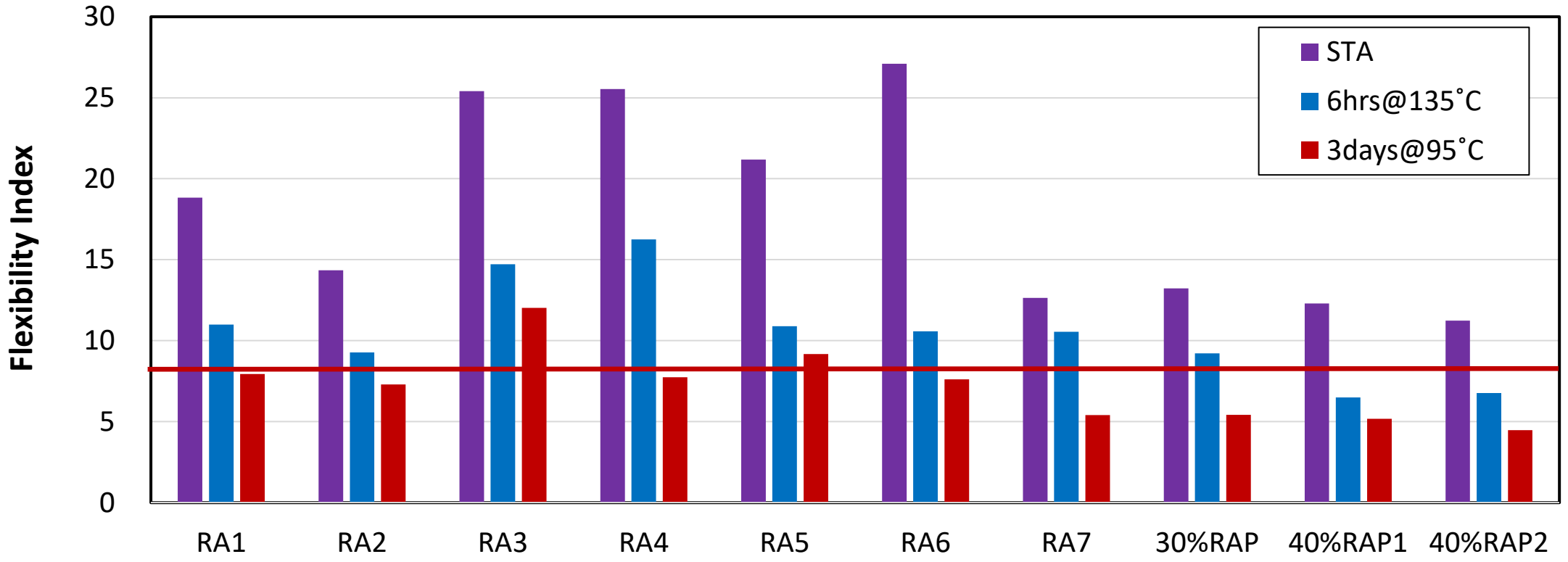
- Only RA7, 30% RAP and 40% RAP1 pass the criteria (10,000@12.5mm)
- Large difference between 40% RAP Day 1 and Day 2

CT-Index(WisDOT)



- RA3, RA4 and RA5 show higher CT-Index value for both plant and 6 hrs@135˚C
- 40% RAP Day 1 and Day 2 similar

Flexibility Index (IDOT)



- RA3 and RA4 show higher FI value before/after long-term conditioning
- RA6 show the highest FI value after production
- 40% RAP Day 1 and Day 2 similar

Task 1: State of the Art Review

- *Chapter-1:* Introduction *(Complete)*
- *Chapter-2:* Definition, Types and Properties of Rejuvenators *(Complete)*
- *Chapter-3:* Current Methods and Practices for Evaluation of Rejuvenated Asphalt Binders *(On-going)*
- *Chapter-4:* Current Methods and Practices for Evaluation of Rejuvenated Asphalt Mixtures *(On-going)*
- *Chapter-5:* Long-term Performance of Rejuvenated Asphalt Materials *(Complete)*
  - **Concerns** of long-term performance of rejuvenated asphalt materials
  - **Laboratory conditioning methods** to simulate asphalt field aging (mixture conditioning methods)
- *Chapter-6:* Summary and Conclusions

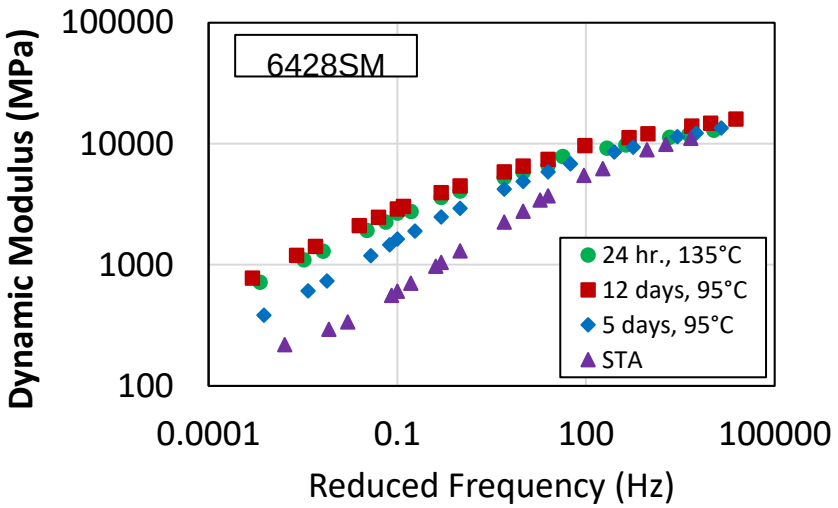
Literature Review: Long-term Aging Conditioning of Mixture

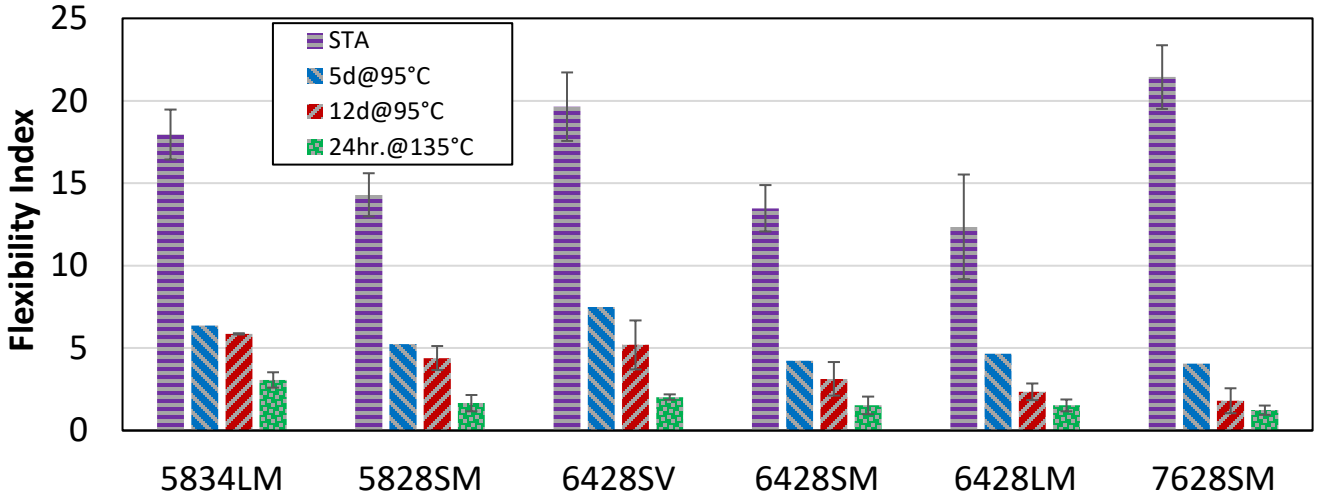
- **Loose State** (compacted state not considered w/challenges)
  - Summary: days@70-95˚C; hours@135˚C
  - **Asphalt Institute/NCAT: hours@135˚C**
    - ✓ NCAT: Correlate with field aging based on Cumulative Degree Day (CDD)
    - ✓ 6 hrs@135 = **3-4 years** aging; 8hrs@135˚C = **70,000 CDD** field aging
    - ✓ **UNH & MTE:** 24 hrs@135 = 20 years aging (binder from top ½" of field core)
    - ✓ **UNH:** 10 years aging (|E*| on field cores)
  - **NCHRP 09-54: days@95˚C**
    - ✓ Correlate with field aging (aging gradient) based on Climatic Aging Index (CAI) Model
    - ✓ 3 days@95˚C = **4 years**; 11-13 days@95˚C = **16 years** (top ½" using aging map)
    - ✓ **UNH:** 5 days = 8 years; 12 days = 20 years aging (binder from top ½" of field core)

      5 days = 4 years; 12 days = 10 years aging (|E*| on field cores)

Comparison between Different Mixture Conditioning Methods

- **Asphalt Institute/NCAT: hours@135˚C**
  - **Advantages:** practical and readily protocol; widely accepted; consistent with **6 hrs@135˚C** we have selected
  - **Disadvantage:** Unknown affect on chemistry/rheology; may affect cracking properties





- **NCHRP 09-54: days@95˚C**
  - **Advantages:** Don't have potential problems associated above 100˚C
  - **Disadvantage:** Takes time (days); stirred and mixed mixture every two days

Summary and Next Steps

- **Task 1: Literature Review and Monitoring Coordination**
  - Literature review is being conducted
  - Material is being shipped to research team
  - Task 1 deliverable will be submitted to TAP for review (February 2021)

- **Next Steps:**
  - Complete literature review and prepare, submit Task 1 deliverable
  - Aging conditioning and sample preparation
  - Begin collating construction data, binder testing and mix testing
  - Next TAP meeting (February 2021)

Thank you for your attention!

Questions and Comments?

University of New Hampshire

National Road Research Alliance

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Task 3: Plant Produced Mixture and Field Core Testing

Mixture Performance Test	Laboratory Conditioning			Field Cores
	Unaged	6 hours at 135°C	Additional long-term condition	
Disk-shaped Compact Tension (DCT)	✔	✔	x	-
Hamburg Wheel Track Testing (HWTT)	✔	-	-	-
Tensile Strength Ratio (TSR)	✔	✔	-	-
Ideal Cracking Test (CT-Index)	✔	✔	-	-
Complex Modulus (E*)	x	x	o	x
Direct Tension Cyclic Fatigue (DTCF)	x	x	o	x
Stress Sweep Rutting (SSR)	o	-	-	-

✔: conducted by NRRA members x: conducted by research team

o: conducted based on need determined from other test results and availability of materials

Task 4: Binder Testing

Binder Type	Unaged	Binder Conditioning Levels				Plant Produced Loose Mixture Conditioning Levels	
		RTFO	20 hours PAV	40 hours PAV	60 hours PAV	6 hours at 135°C	2nd aging condition
Virgin (tank/inline sampled) Binder	✔	✔	✔	-	-	NA	NA
Binder Extracted and Recovered from Plant Produced Loose Mixture	✔	-	✔	✔	✔	✔	✔
Binder Extracted and Recovered from Field Cores (top 1/2 inch)	✔	-	-	-	-	NA	NA
RAP only	✔	-	-	-	-	NA	NA

- Rheological characterization: master curves, indices, PG
- Chemical characterization: SARA, FTIR
- Binder fatigue: LAS