U.S. Department of Transportation
Federal Highway Administration

Turner-Fairbank Highway Research Center

Recent Developments from FHWA's Asphalt Materials Research Program

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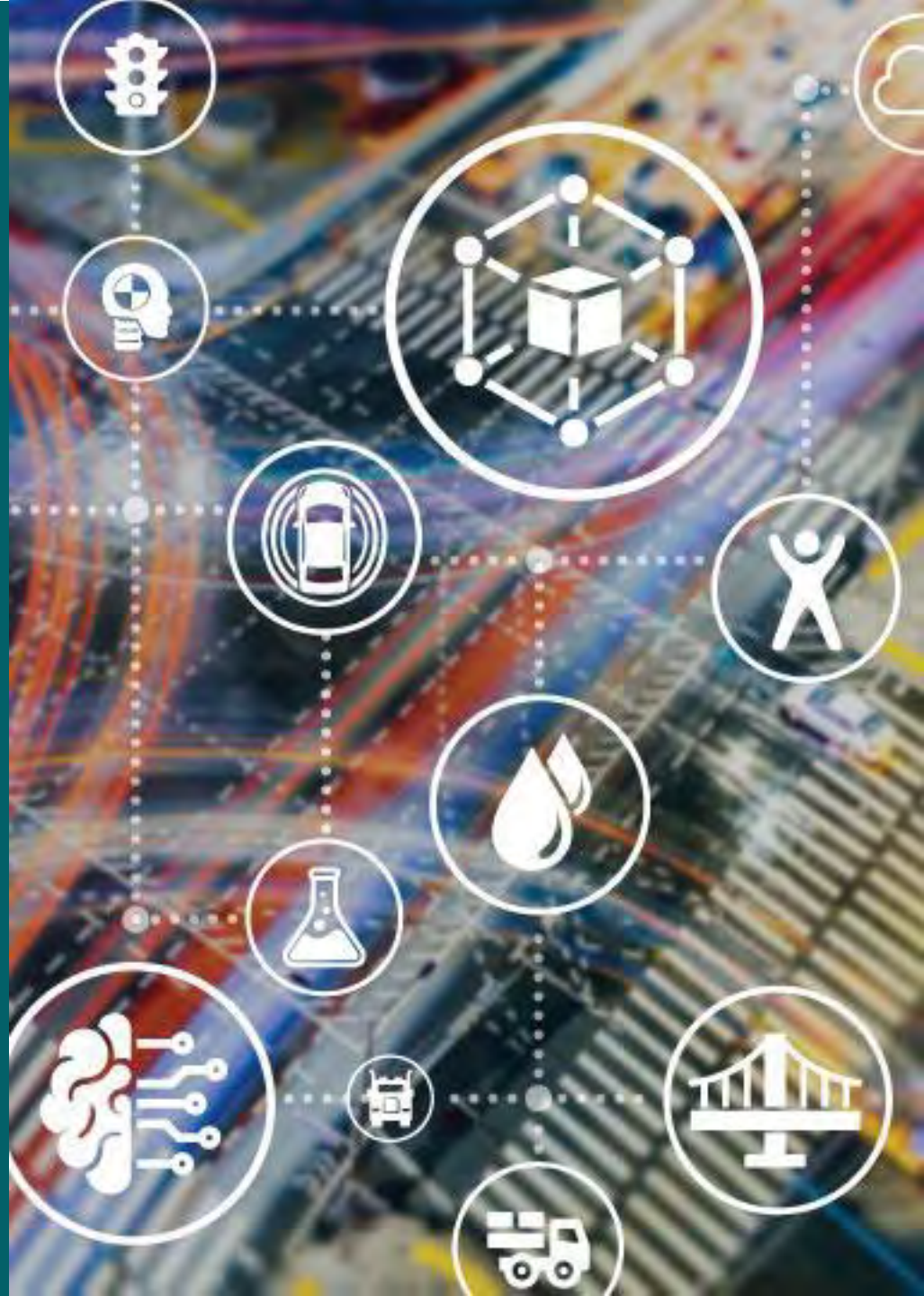
Office of Infrastructure Research and Development

January 18, 2022



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Acronyms

- AASHTO: American Association of State Highway and Transportation Officials.
- ABML: Asphalt Binder and Mixture Laboratory.
- ABML-ID: Asphalt Binder and Mixture Laboratory – Implementation and Delivery.
- ABR: Asphalt binder replacement.
- ABTL: Asphalt Binder Testing Laboratory.
- AC: Asphalt content.
- AE: Automated extraction.
- ALF: Accelerated Loading Facility.
- BMD: Balanced mixture design.
- CT_{Index}: Cracking tolerance index.
- δ: Phase angle.
- DO: FHWA Division office.
- |E*|: Dynamic modulus.
- FHWA: Federal Highway Administration.
- FI: Flexibility Index.
- FLH: Federal Lands Highway.
- I-FIT: Illinois Flexibility Index Test.
- ITC: Indirect Tensile Cracking.
- LTOA: Long-term oven aging.
- MATC: Mobile Asphalt Technology Center.
- PG: Performance grade.
- PTF: Pavement Test Facility.
- RAP: Reclaimed asphalt pavement.
- RAS: Reclaimed asphalt shingles.
- Sapp: Apparent damage capacity.
- SCB: Semi circular bend test.
- SHA: State highway agency.
- STOA: Short-term oven aging.
- TCE: Trichloroethylene.
- TE: Traditional extraction.
- TFHRC: Turner-Fairbank Highway Research Center.

Agenda

1. Program Overview
2. Mixture Performance Test Comparison Study
3. Automated Extraction Comparison Study

FHWA's Asphalt Materials Research Program

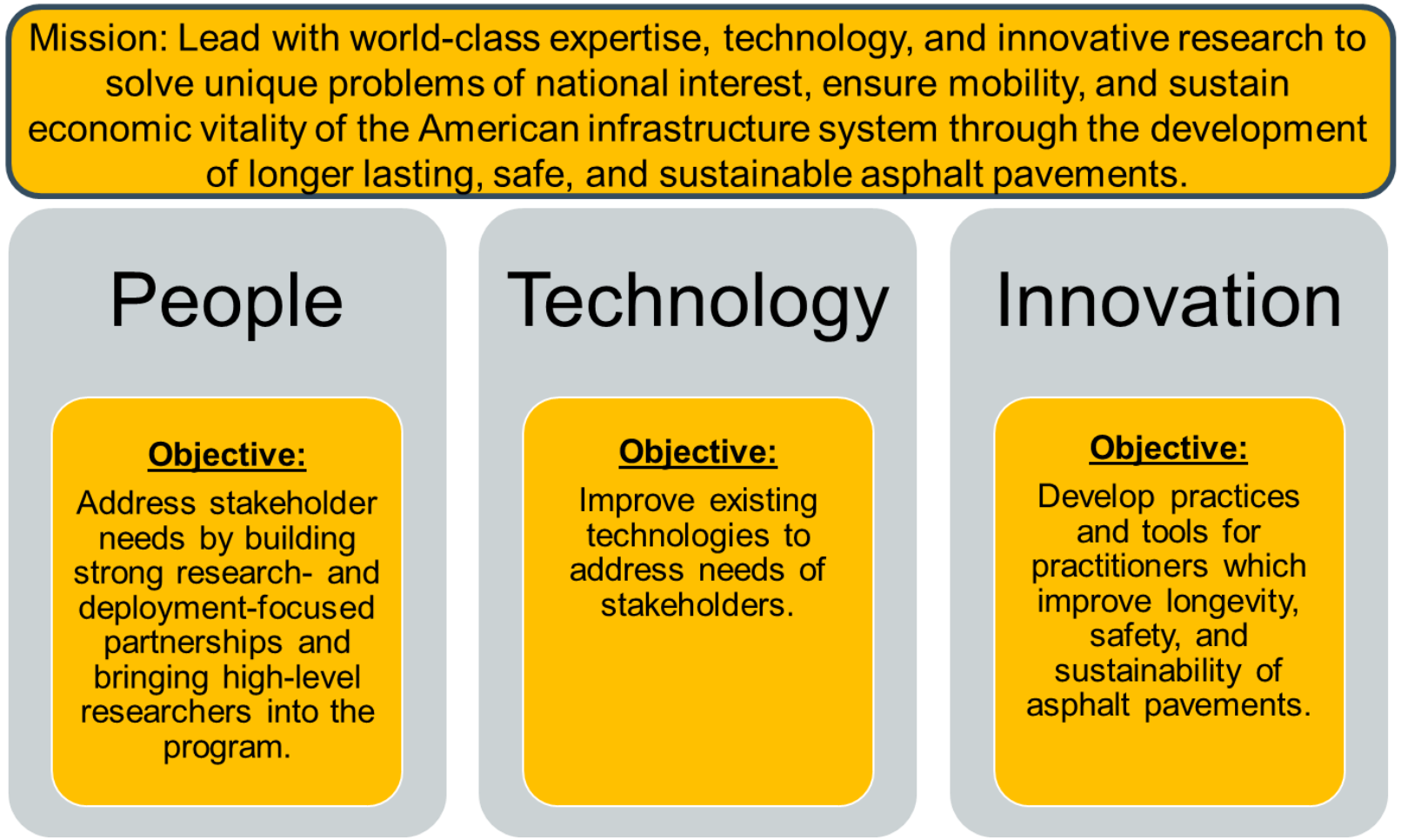
Overview

U.S. Department of Transportation
Federal Highway Administration
Turner-Fairbank Highway Research Center

Let's Start with…Issues.

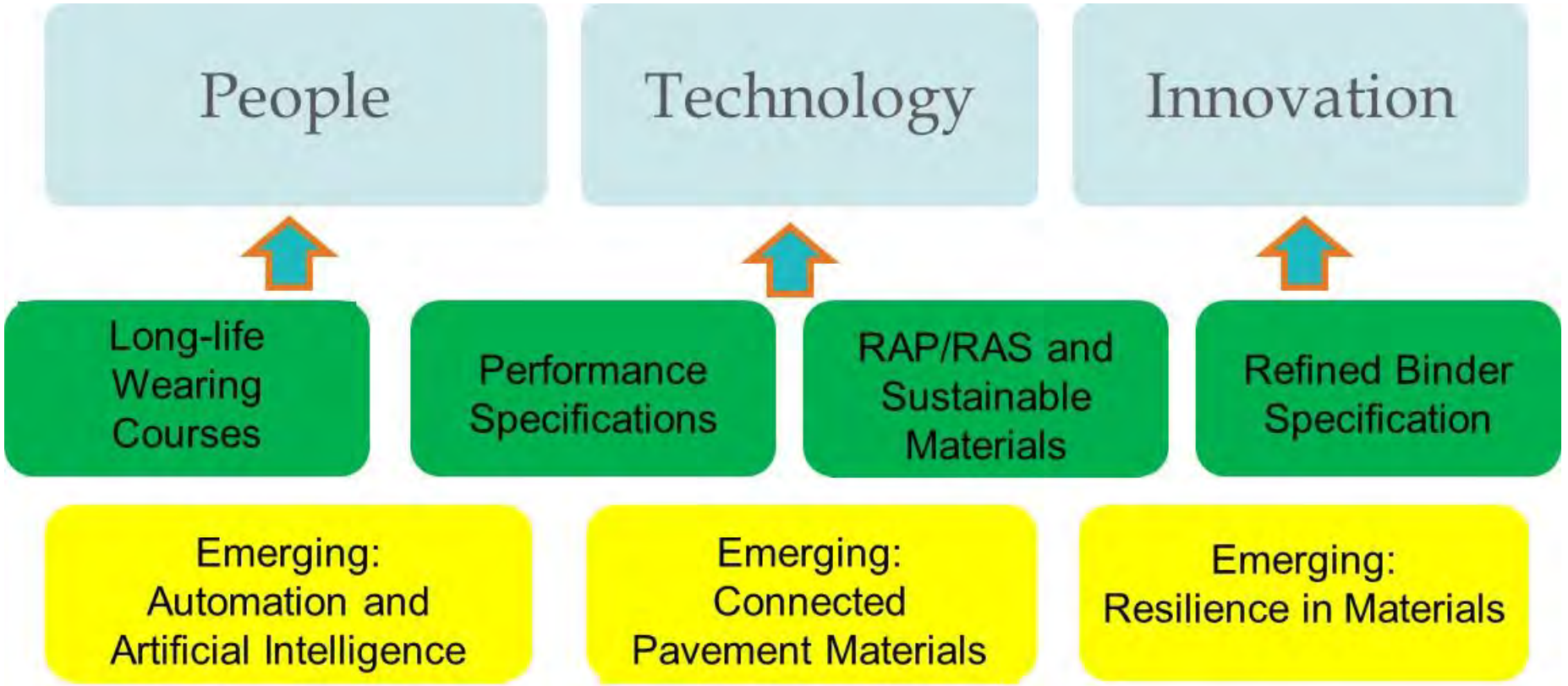
- Critical issues impacting infrastructure (and therefore, asphalt pavements) in the US.
  - Increasing traffic and climatic demands.
  - Increasing competition in the global marketplace.
  - Changing quality and quantity of resources.
  - Evolving world of automation and the Internet of Things.
  - Decreasing experience and availability of agency workforce.

Strategic Overview of the Program



Source: FHWA

Program Focus Areas



Source: FHWA

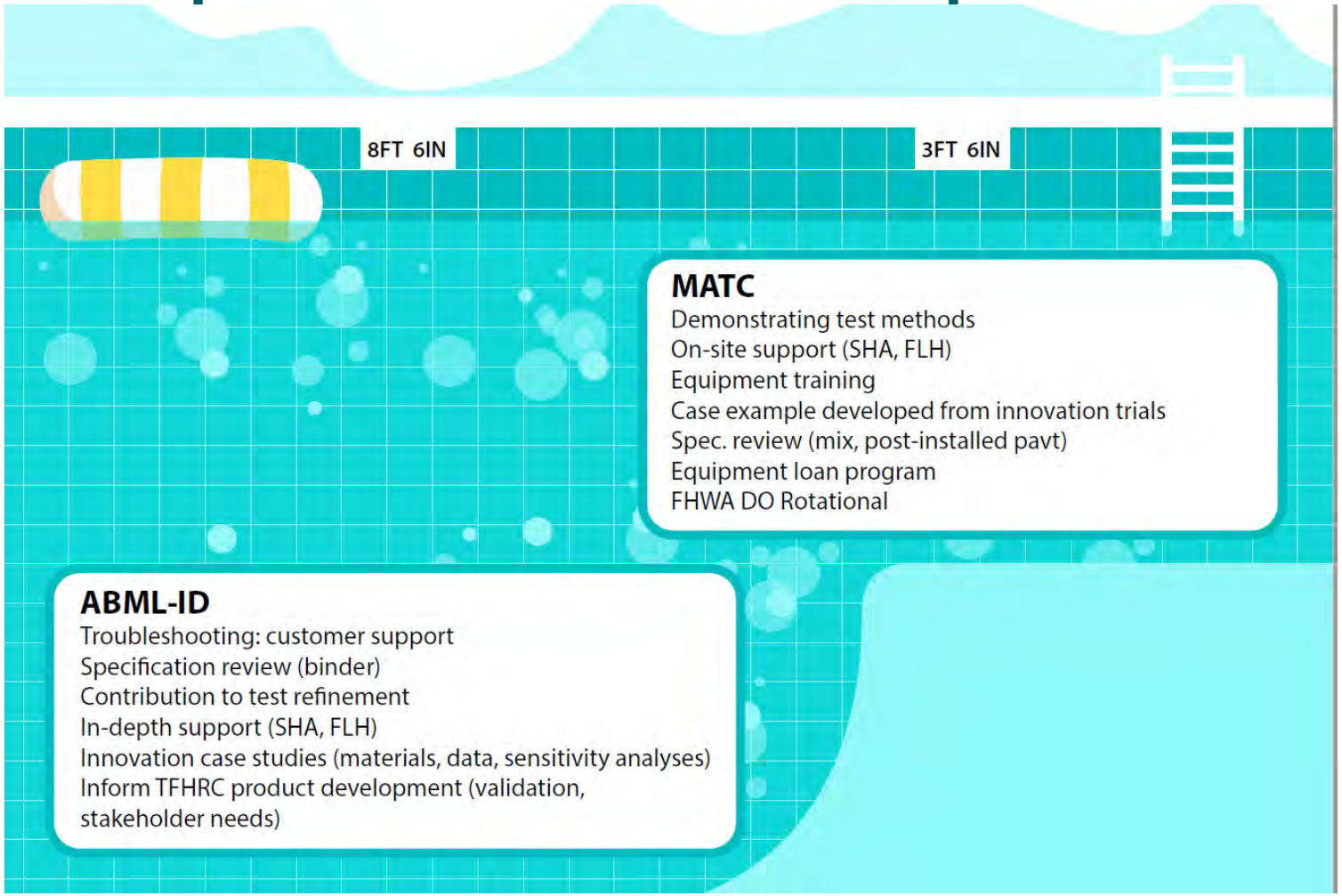
Structure of Program

- Asphalt Binder and Mixture Laboratory.
  - Research.
  - Implementation and Delivery.
- Pavement Test Facility (PTF).
- Out-of-house, Contracted Research.
  - As-needed efforts.
  - Connecting the last dots.
- Visiting scholars.

ABML-ID

- Background
  - Mobile Asphalt Testing Trailer (now Mobile Asphalt Technology Center or MATC) had operated the Asphalt Binder Testing Laboratory (ABTL) for 25+ years.
  - Primarily housed at TFHRC.
  - Critical review of trailer program led to repurposing of ABTL resource.
- Goals
  - Create active support mechanism for implementation-focused activities.
  - Lead advancement of TFHRC products into field evaluation and deployment.
  - Engage internal stakeholders to actively respond to State concerns in short-order.

The “Deeper Dive” Concept



Source: FHWA

ABML-ID Process

- What would be an ideal requested project?
  - High-impact (multiple States and FHWA interest).
  - Short-duration (6-12 months to completion best).
  - Will generate multiple products that can be broadcast to national audience.
- How do I request a project?
  - Send a request form to D. Mensching via FHWA Division Office P&M engineer.
  - Form is available.
    - Potential products identified upfront.
    - Follow-up discussion with requestor possible.

Pavement Test Facility

- Originated in 1986.
- FHWA's accelerated loading facility (ALF).
- Past and current studies: plastics, Superpave validation, RAP/RAS, density.
- Major reconstruction underway!
  - New ATLAS testing machines.
  - 11 new lanes.
  - 4 new substructures.
  - Flooding capability.


Source: FHWA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Mixture Research Highlight

Mixture Performance Test Comparison Study

U.S. Department of Transportation
Federal Highway Administration
Turner-Fairbank Highway Research Center

“The Rodeo”

- Initiated in 2018 to compare intermediate temperature cracking tests being considered by community.
- Stakeholder input selected 6 tests for initial study.
- Project duration was 30 months.
  - Phase I: Reheated plant mixes from ALF.
  - Phase II: Long-term oven aged plant mixes from ALF.
  - Phase III: State mixes.
    - Insights on stiffness dependency.
    - Role of binder testing in BMD.
- Extension effort recently approved, will include recycling agents and polymers.

Objectives

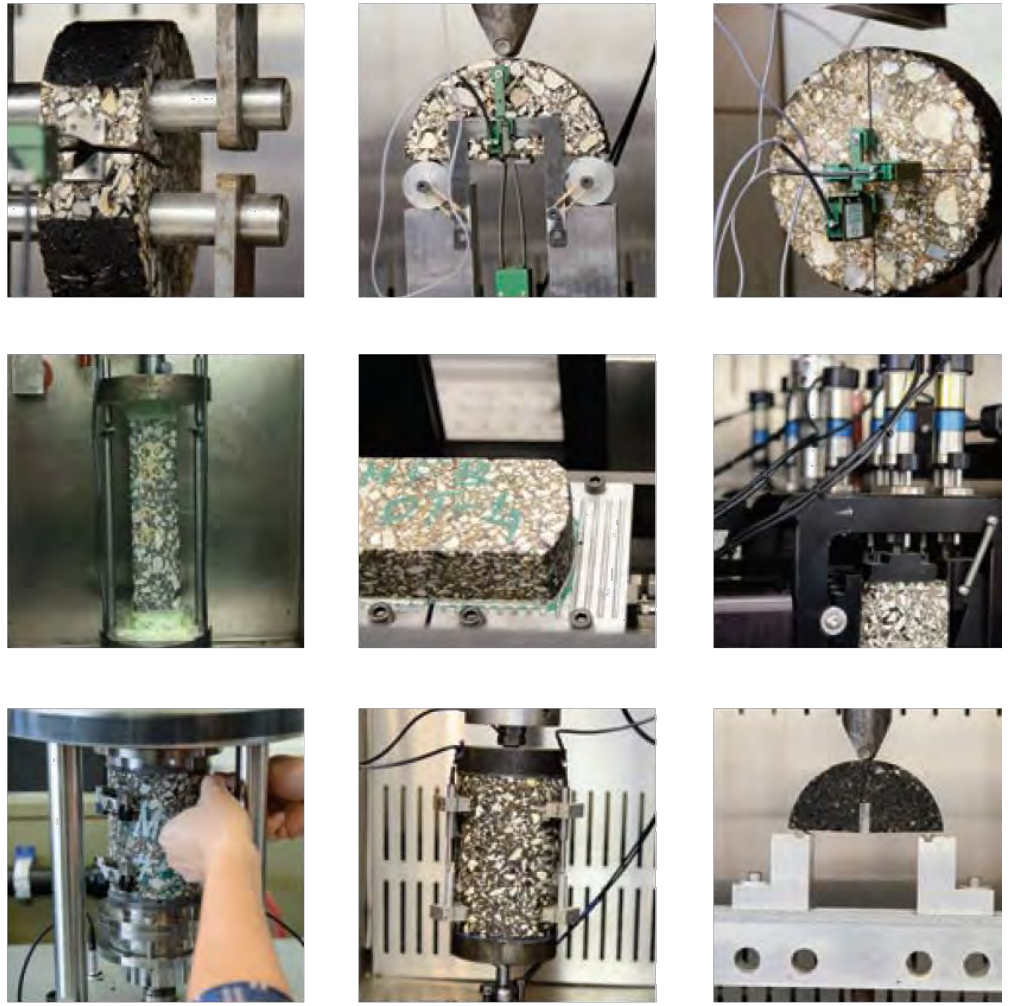
- Compare the impact of various aging protocols on mixture performance test results.

Cracking Tests – Phase II

- List of Cracking Tests
  - Dynamic Modulus Test.
  - Uniaxial Cyclic Fatigue Test.
  - SCB Test

    University of Illinois – Intermediate Temp (I-FIT).
  - ITC Test.

    (a.k.a., IDEAL-CT).
- ***LTOA protocol?!***

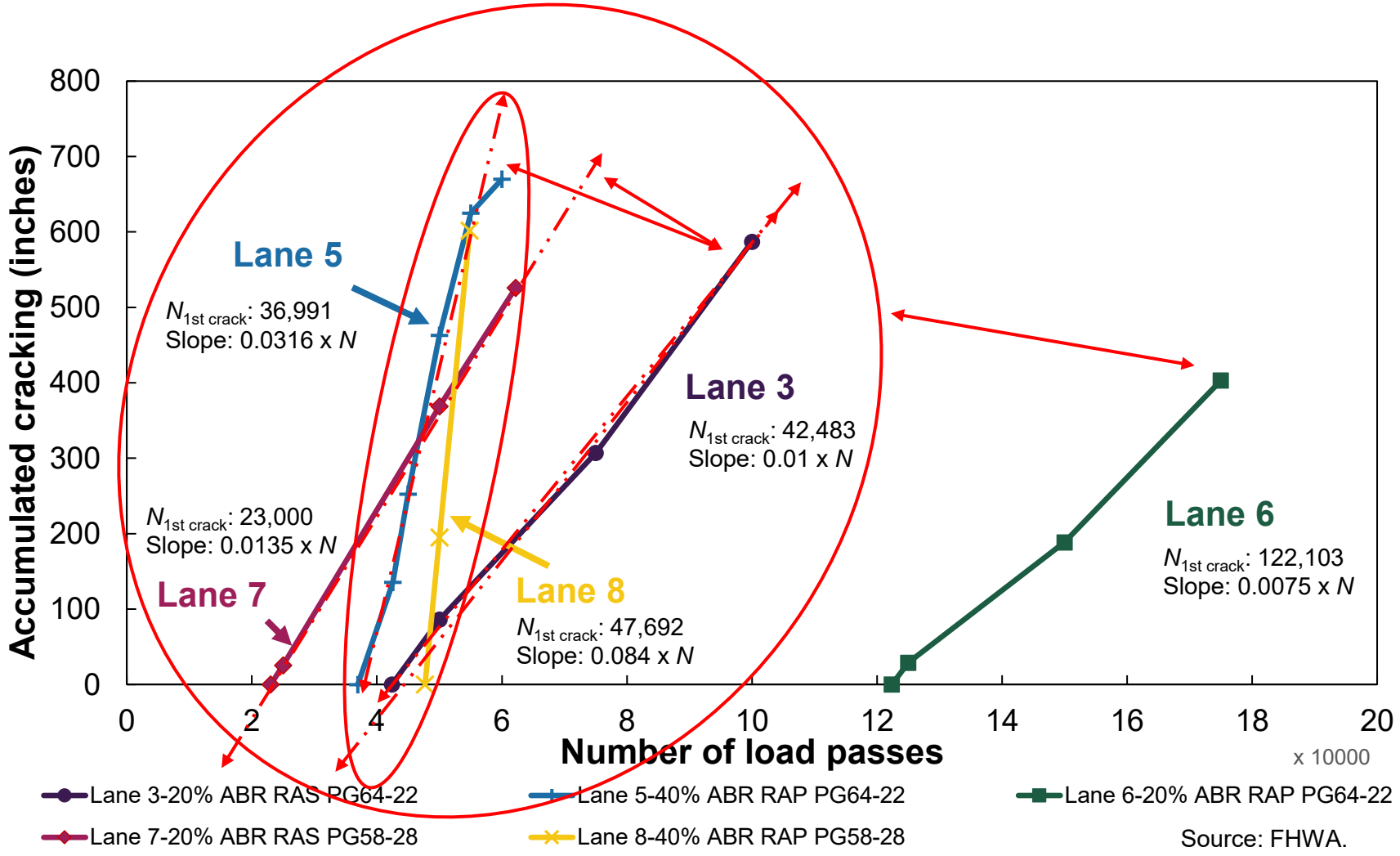


From *NCHRP Research Project 09-57 Booklet: Experimental Design for Field Validation of Laboratory Tests to Assess Cracking Resistance of Asphalt Mixtures*, Cracking Test Workshop, Newport Beach, CA, 2015, cover. Copyright, National Academy of Sciences. Reproduced with permission of the Transportation Research Board. http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP09-57_TestBooklet.pdf.

ALF Materials

	HMA/WMA Drum Discharge Temp	149°C (300°F) – 160°C (320°F)		116°C (240°F) – 132°C (270°F)	
Recycle Content	Warm Mix Technology	None		Foam	Chemical
	0%	PG 64-22		N/A	N/A
	20% ABR RAP ≈ 23% RAP by weight	PG 64-22		PG 64-22	PG 64-22
	20% ABR RAS ≈ 6% RAS by weight	PG 64-22	PG 58-28	N/A	N/A
	40% ABR RAP ≈ 44% RAP by weight	PG 64-22	PG 58-28	PG 58-28	PG 58-28

Accelerated Performance Testing



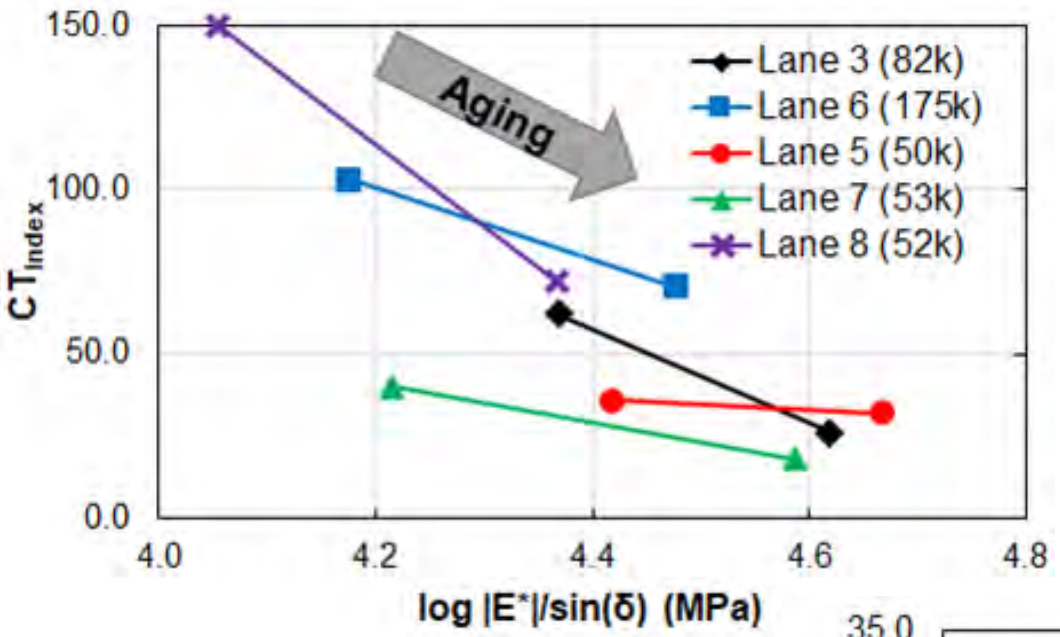
Lane	$N_{1st\ Crack}$	Slope
3	42,483	0.0100
5	36,991	0.0316
6	122,103	0.0075
7	23,000	0.0135
8	47,692	0.0840

Clear Observations
L5 ≈ L8
L3 > L7
L3 > L5
L6 >> L3

Indices to Evaluate

- Cracking
  - Uniaxial Cyclic Fatigue → S_{app} (apparent damage capacity)
  - I-FIT → FI (flexibility index)
  - ITC → CT_{Index} (cracking tolerance index)
- Aging
  - Linear viscoelasticity → $|E^*|/\sin \delta$

Mapping Aging Index to Cracking Indices



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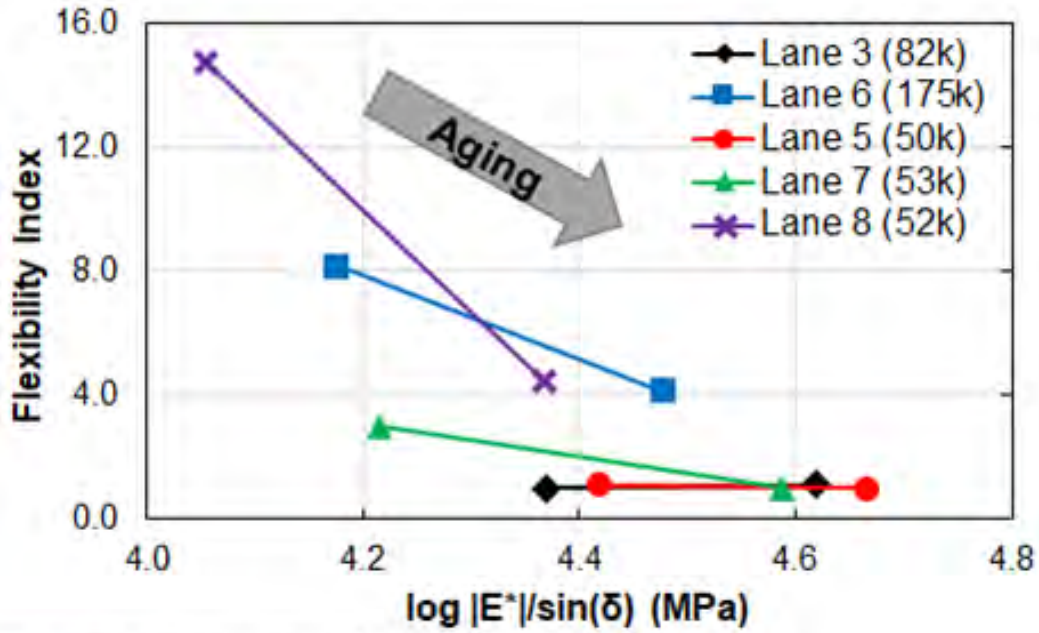

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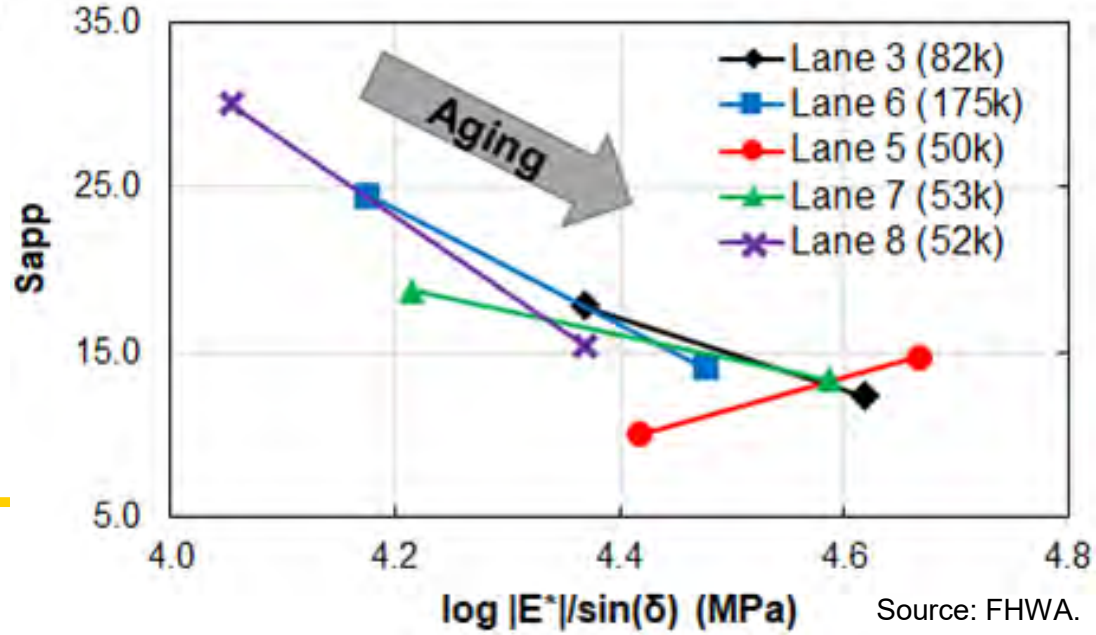


Source: FHWA.

Findings

- The use of $\frac{|E^*|}{\sin(\delta)}$ as a viable aging index for mixtures is further confirmed.
- Cracking indices often collapse with LTOA while the $\frac{|E^*|}{\sin(\delta)}$ property continues to change in a logical fashion when considering base binder grade and RAP/RAS content.
  - This has implications for BMD as mixtures designed with similar materials can be discriminated against in a STOA state, but not after LTOA.
  - Consider conducting BMDs at LTOA to target material combinations that will separate and correlate to performance over time.

Binder Study Highlight

Automated Extraction Comparison Study

U.S. Department of Transportation
Federal Highway Administration
Turner-Fairbank Highway Research Center

Objective

- To compare properties changes of RAP blended asphalt binders extracted from traditional extraction method (AASHTO T 164, Method A*) and automated extraction device and to determine the impact on blending charts.

AASHTO - American Association of State Highway and Transportation Officials

*AASHTO, Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA), Method A, 2014.

Study Plan

- Methods.
  - Automated Extraction (ASTM D8159-19).
  - Traditional Extraction (AASHTO T 164, Method A).
  - TFHRC binder recovery method.
- Materials.
  - PG 64-22.
  - Virgin, 40% RAP, and 100% RAP mixtures.
  - ALF mixture design.
- Evaluated Properties.
  - Continuous grades.
  - Blending charts.
  - Binder content.
  - Gradation.

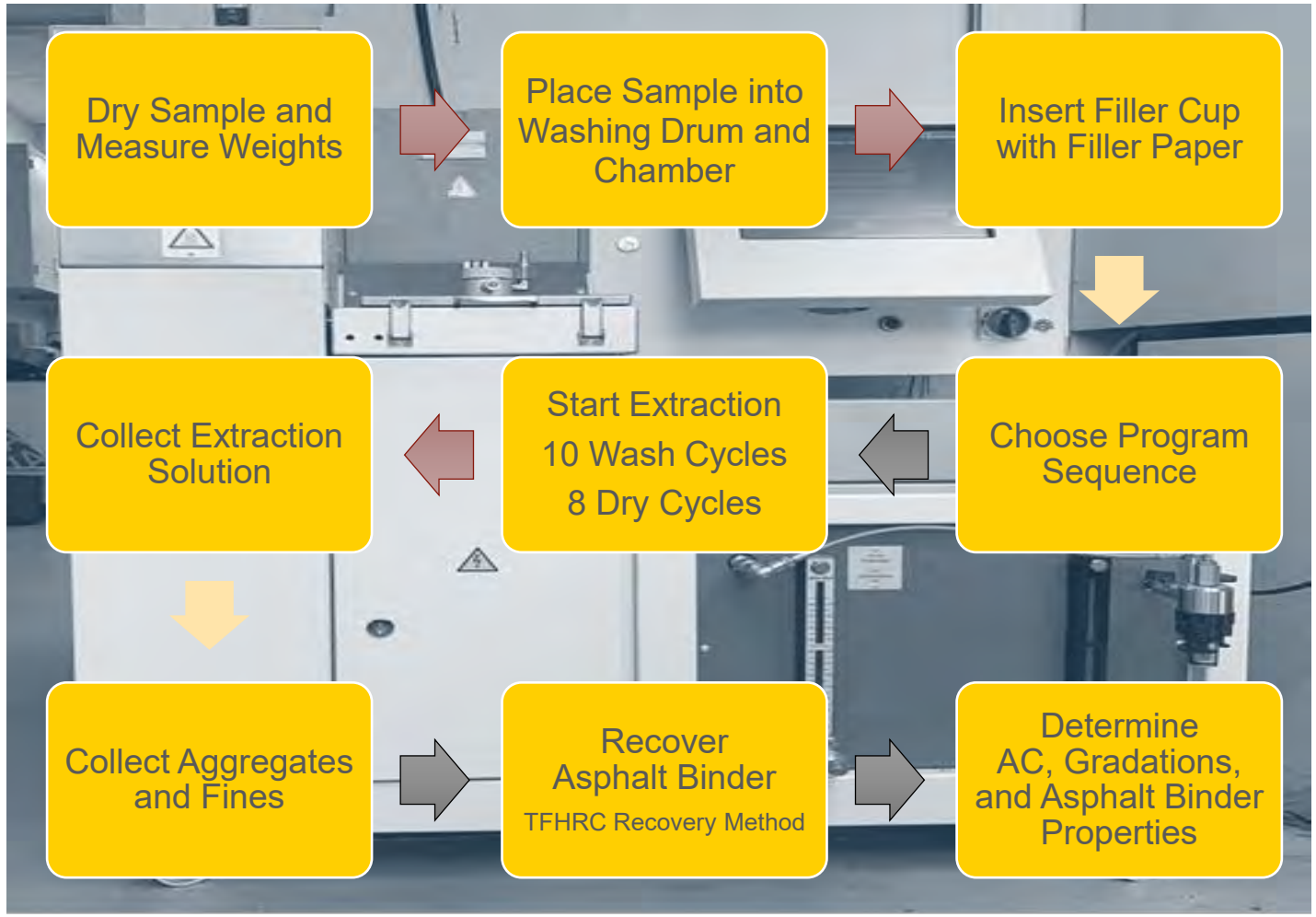
Automated Extraction Device

Automated Extraction Equipment

Washing Drum and Washing Chamber

Centrifuge Filler Cup with Filler Paper

Automated Extraction Procedure



Source: FHWA

AC – Asphalt Content

Traditional Extraction

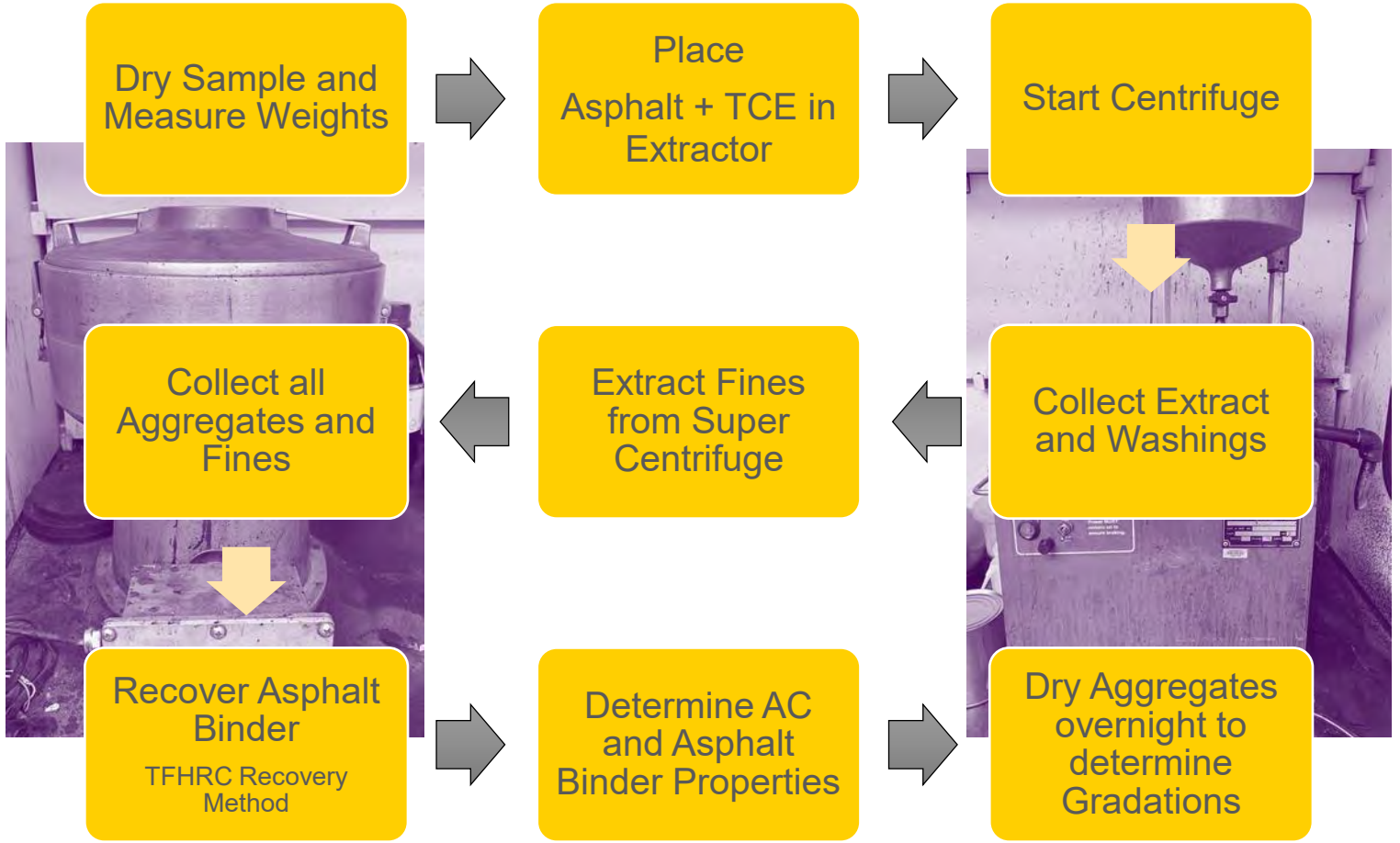
AASHTO T 164, Method A*

Centrifuge Extractor

Super Centrifuge

*AASHTO, Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA), Method A, 2014.

AASHTO T 164, Method A*



Source: FHWA

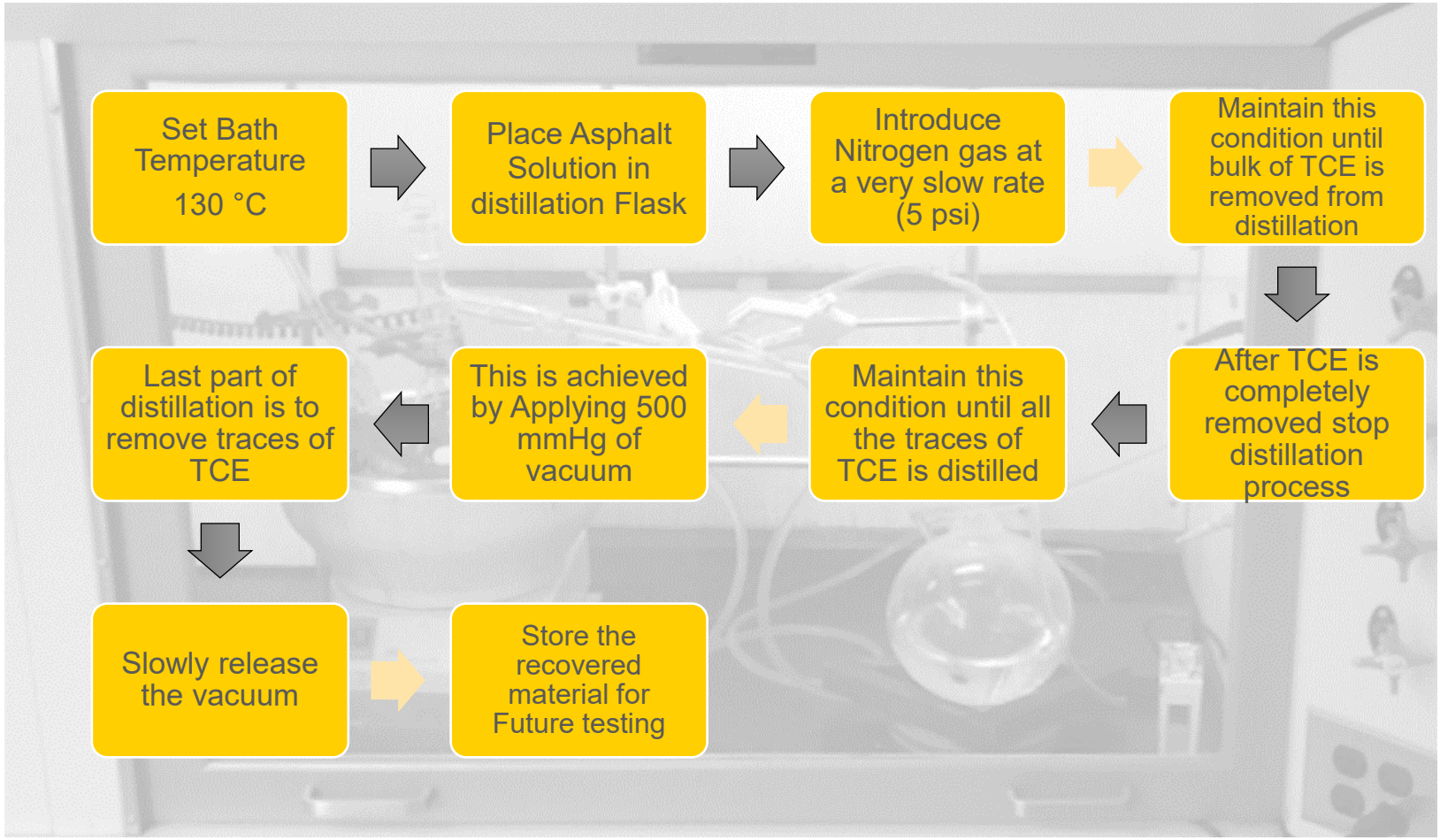
TCE - Trichloroethylene

*AASHTO, Standard Method of Test for Quantitative Extraction of Asphalt Binder from Hot Mix Asphalt (HMA), Method A, 2014.

TFHRC Asphalt Binder Recovery Setup

Source: FHWA

TFHRC Binder Recovery Procedure



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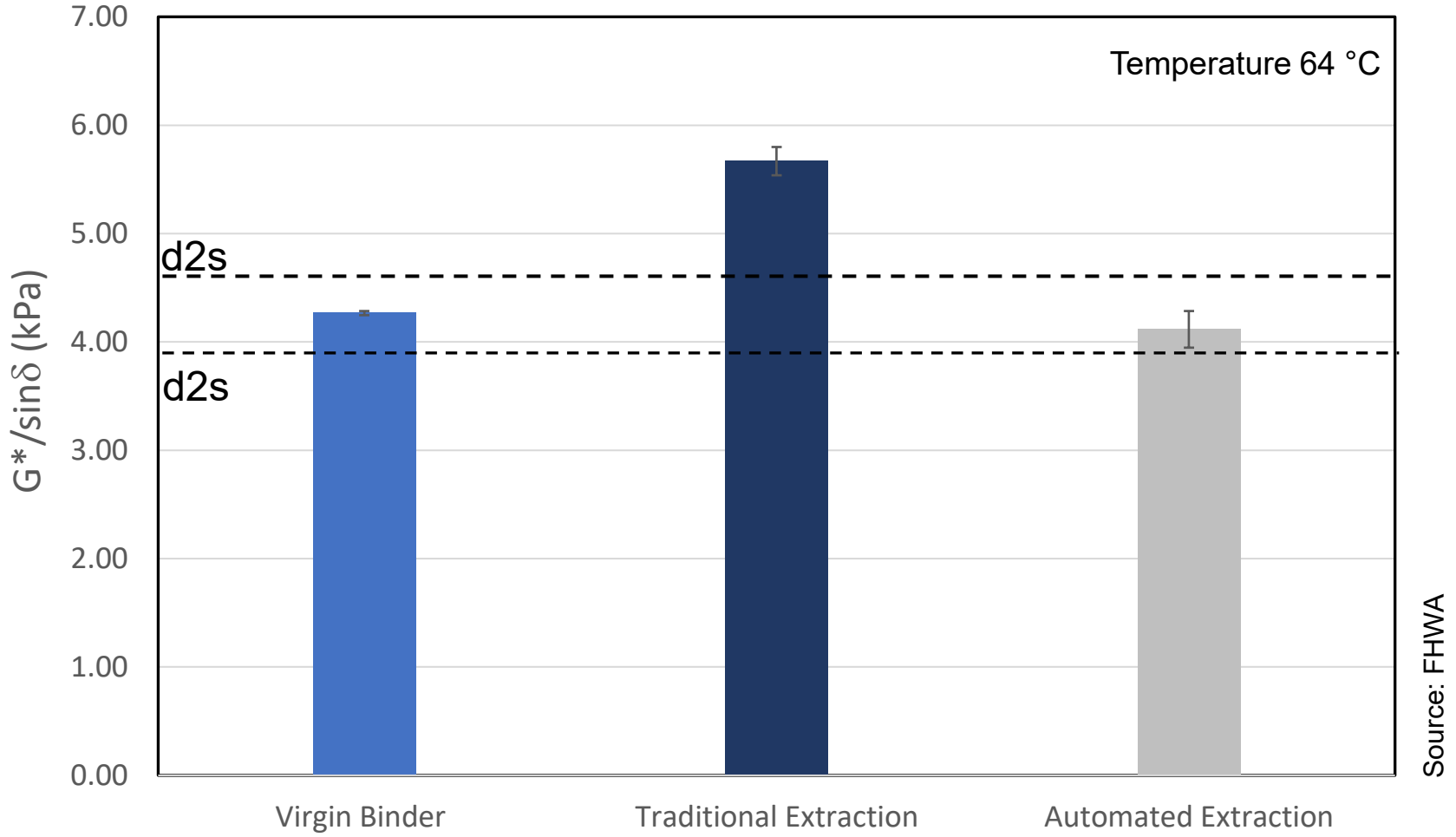
TCE - Trichloroethylene

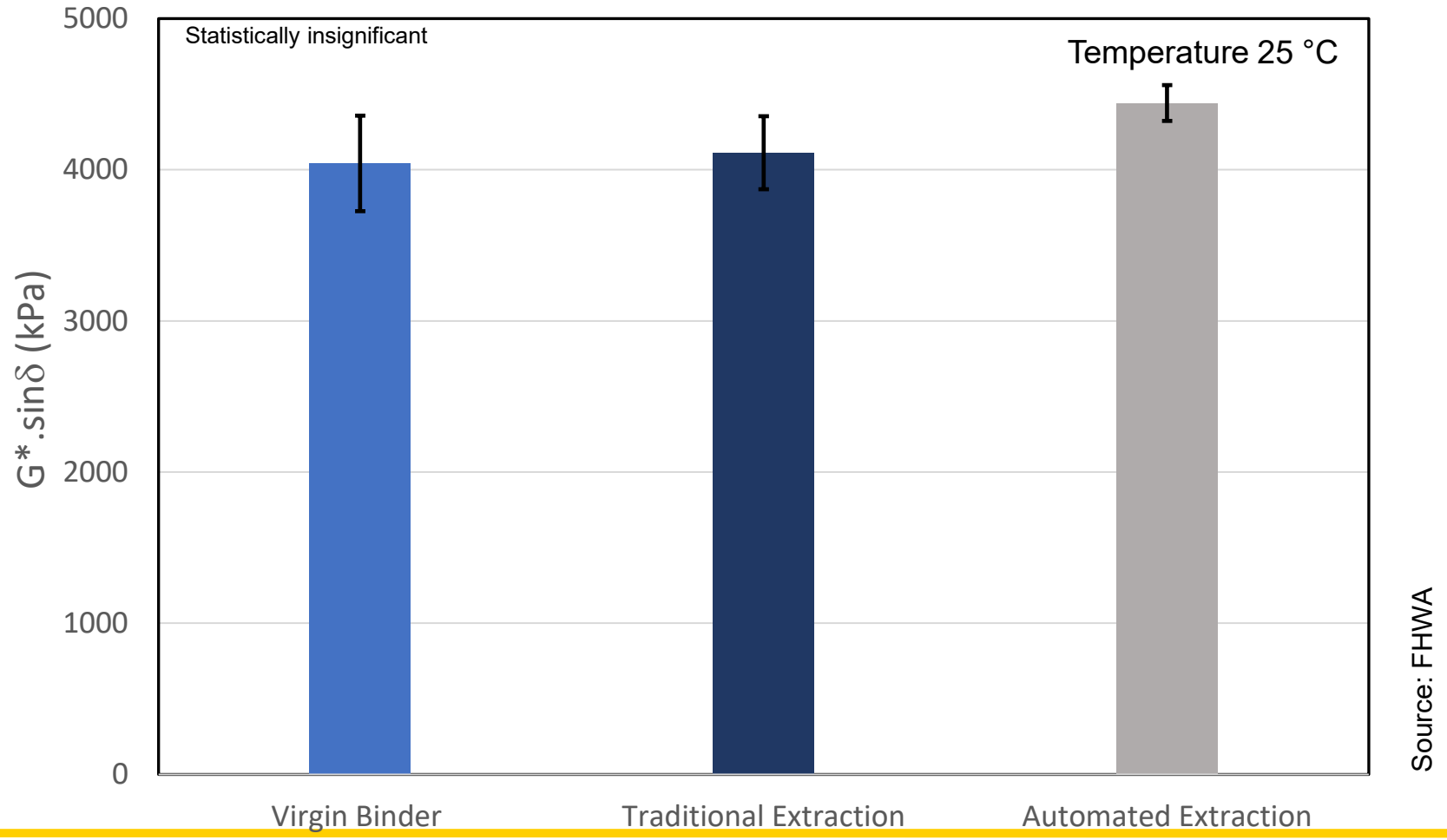
Extraction Methods Comparisons

Virgin(PG 64-22) Recovered Binder

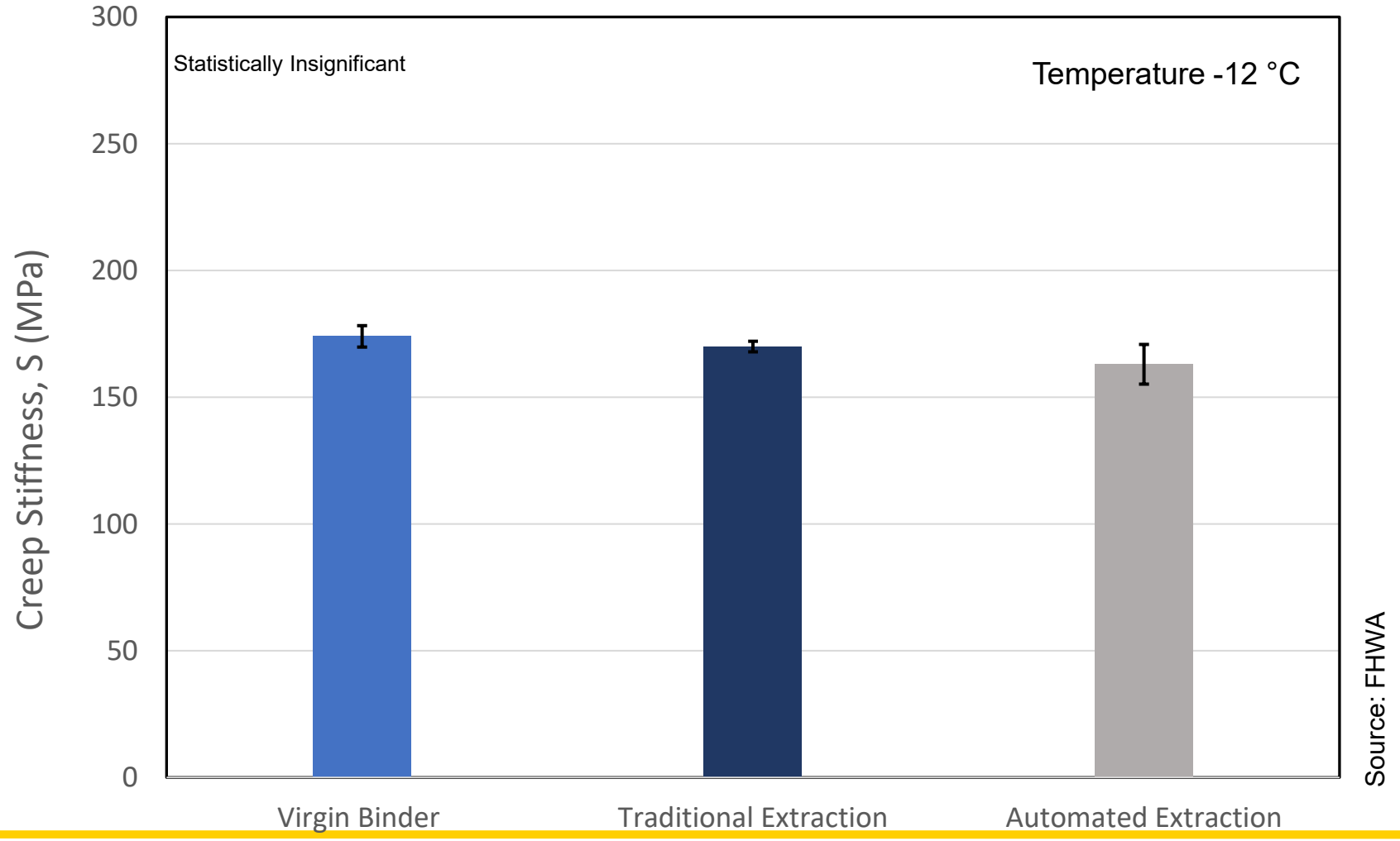


SD Error Bars - 2 Traditional Extractions
2 Automated Extractions
3 DSR reps for Control Binder

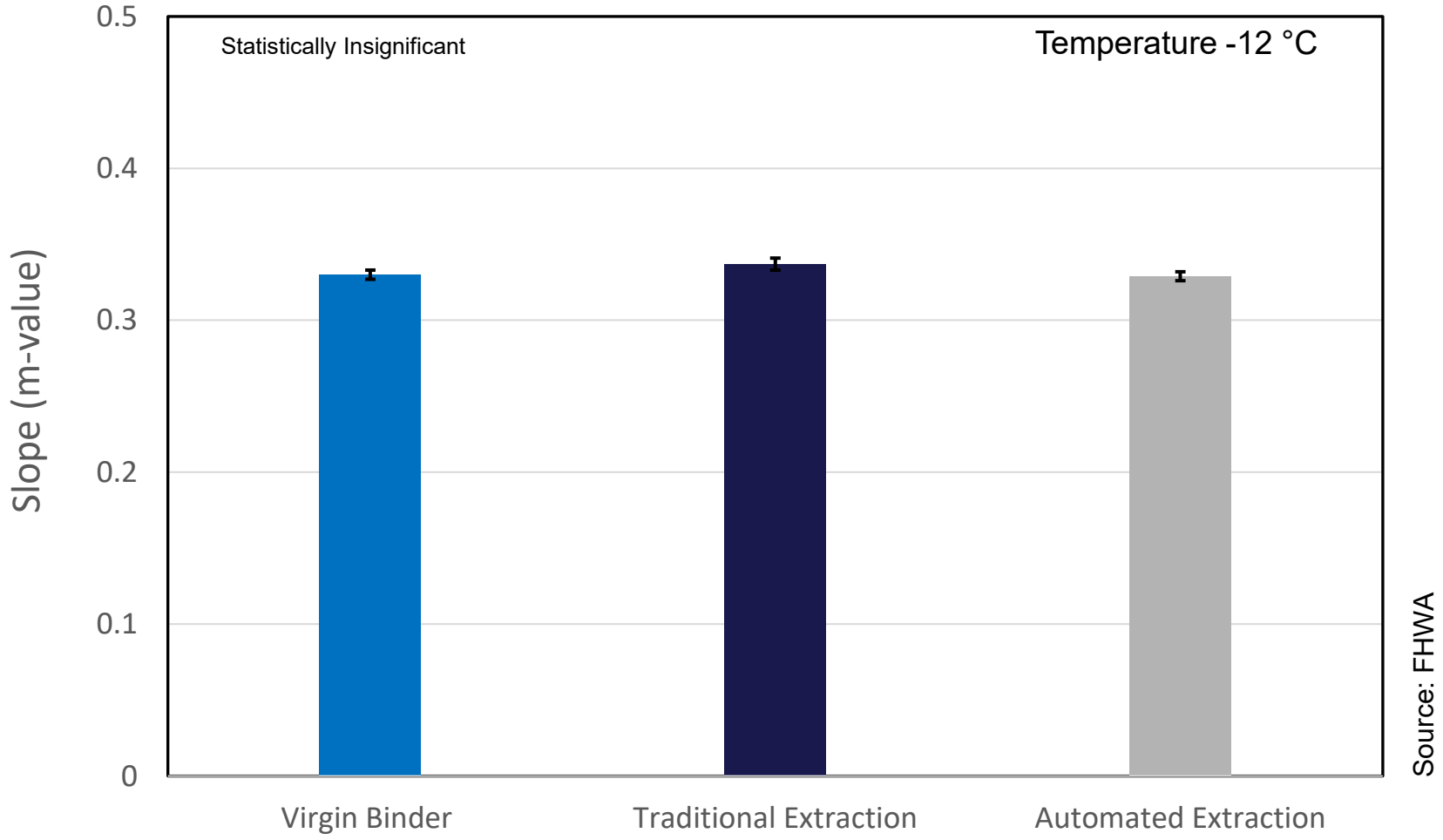
Virgin Binder - Intermediate Temperature



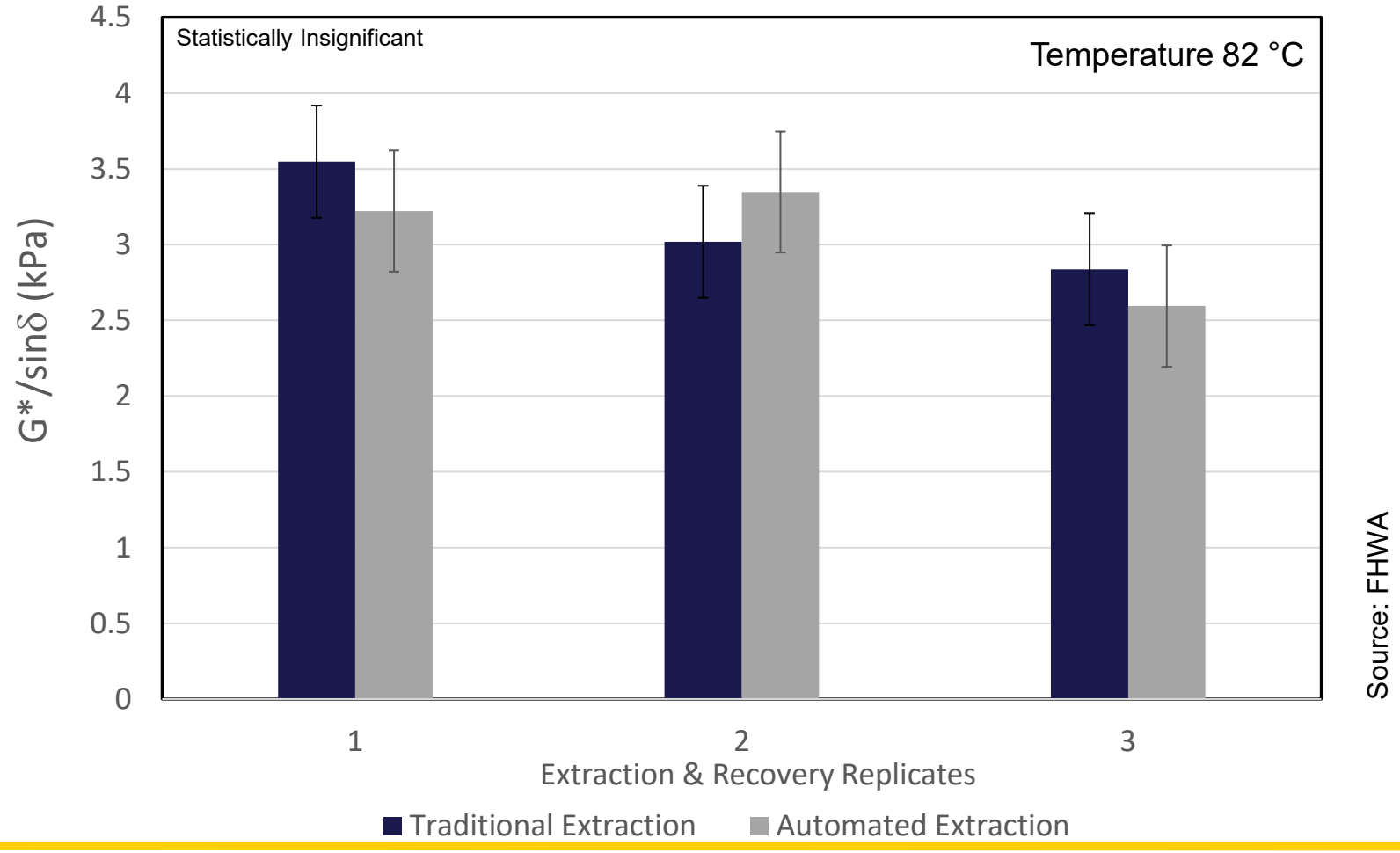
Virgin Binder - Low Temperature Stiffness



Virgin Binder - Low Temperature m-value



40% RAP - High Temperature



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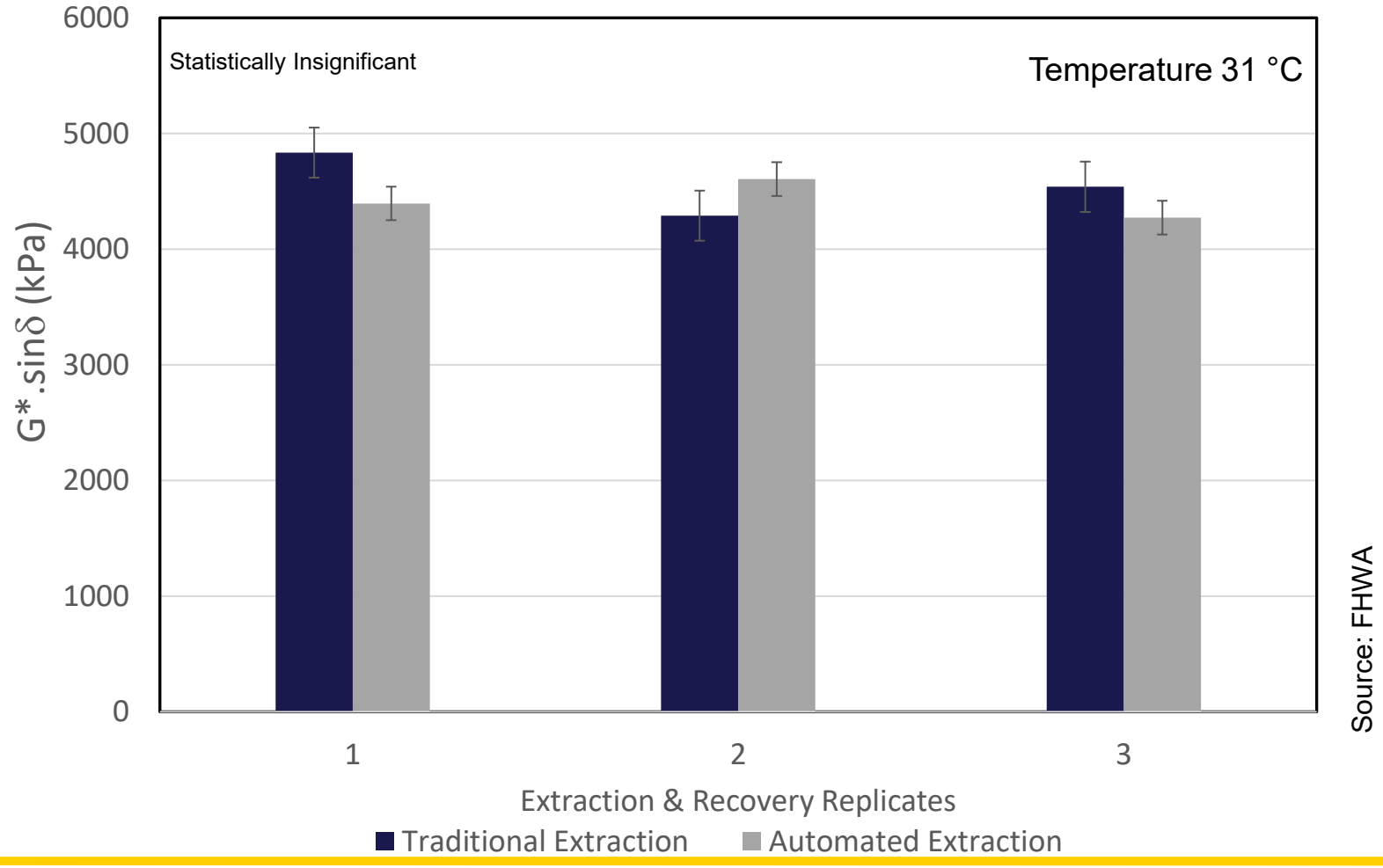
40% RAP – Intermediate Temperature



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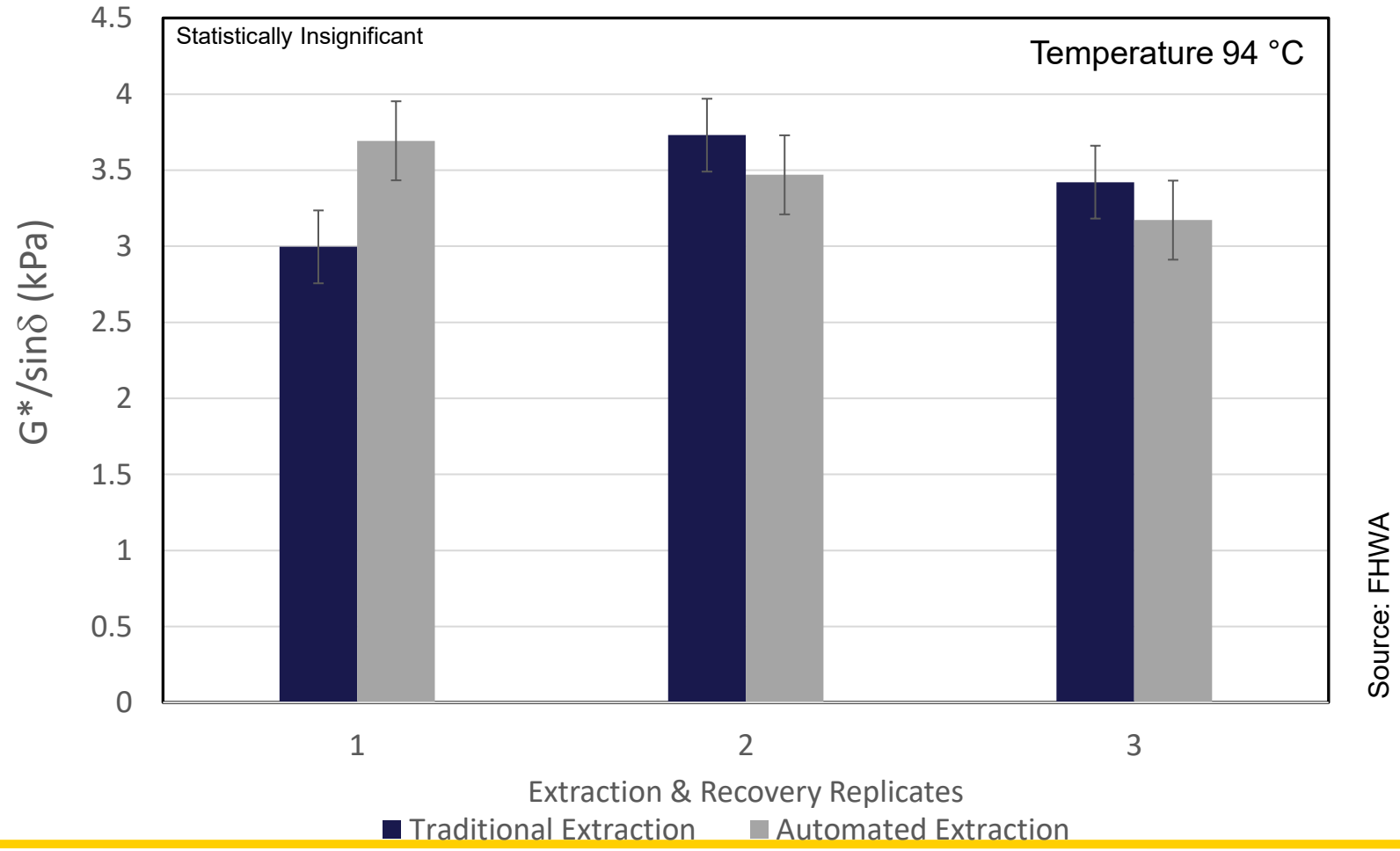
100% RAP - High Temperature



Source: FHWA

Findings

- Physical properties of extracted binder from automated extraction method were similar to the control virgin binder and statistically insignificant.
- Binder properties extracted from conventional extracted binder were stiffer compared to the control virgin binder.
- Asphalt binder properties at intermediate and low temperature extracted from automated and traditional extraction methods were similar compared to the control virgin binder at low and intermediate temperatures.
- The performance grade of extracted binder from automated extractor was found be PG 64-22, similar to the control virgin binder.

1st International Data Science for Pavements Symposium

March 22-24, 2022 – McLean, Virginia

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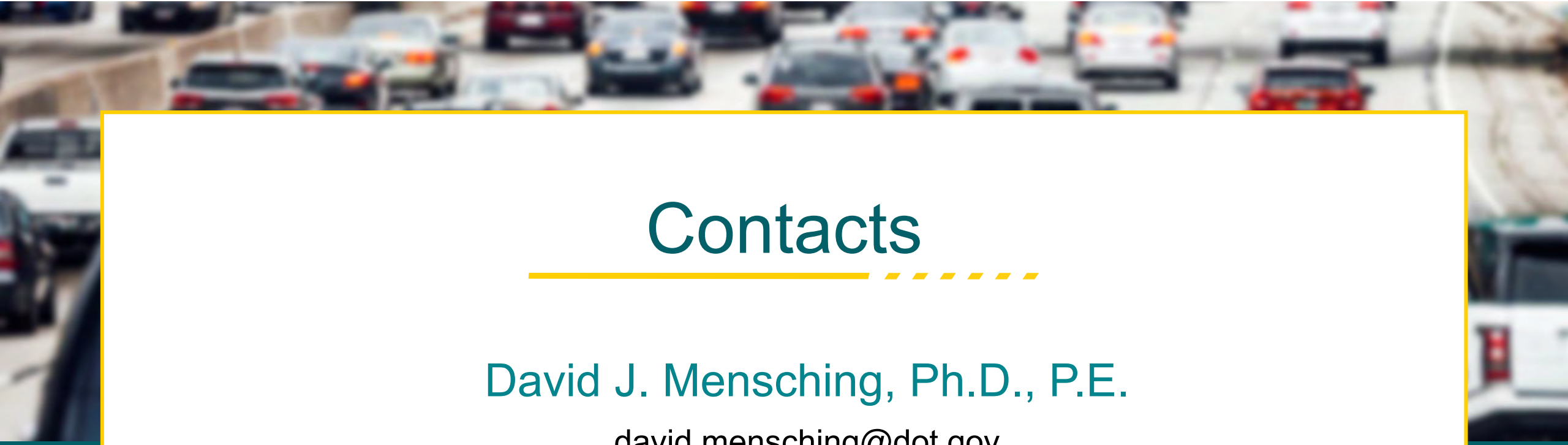
Symposium in Planning!

- FHWA is working in partnership with the Univ. of New Hampshire and Univ. of Missouri to host at TFHRC in a hybrid fashion.
- Goal is to raise awareness of cutting-edge research and identify gaps to broader implementation.
- Student data competition is being held.
- Invitational travel available for agency personnel.
- Visit pavementdatascience.com for more!

Questions?



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