MATC
MOBILE ASPHALT TECHNOLOGY CENTER

U.S. Department of Transportation
Federal Highway Administration

FHWA MATC: Providing Assistance to the Northeast

NEAUPG 2020
October 28, 2020

Unless otherwise noted, FHWA is the source of all images in this presentation.

Acronyms

- ABML-ID: Asphalt binder and mixture laboratory – implementation and delivery
- ABT: Asphalt Binder Tester
- BMD: Balanced mix design
- CalTrans: California Department of Transportation
- CT_{index}: Cracking index
- E*: Dynamic modulus
- FHWA: Federal Highway Administration
- FI: Flexibility Index
- FTIR: Fourier transform infrared spectroscopy
- HWT: Hamburg wheel tracker
- I-FIT: Illinois Flexibility Index Test
- MaineDOT: Maine Department of Transportation
- MATC: Mobile Asphalt Technology Center
- mm: millimeter
- N_{des}: Design gyrations
- NRRI: Normalized rutting resistance index
- PG: Performance grade
- QA: Quality assurance
- RQL: Rejectable quality limit
- RSI: stress sweep rutting index
- S_{app}: cyclic fatigue index parameter
- SIP: Stripping inflection point
- TFHRC: Turner-Fairbanks Highway Research Center
- VBE: Voids filled with effective binder
- VMA: Voids in the mineral aggregate
- VTrans: Vermont Agency of Transportation

Outline

- MATC Overview & Mission
- Ongoing MATC Support to Northeast
  - MaineDOT BMD Data Analysis
  - VTrans BMD Data Analysis
- What can we do for you?

Mobile Asphalt Technology Center

- MATC is on the move to serve the asphalt pavement community!

MATC Mission:

Our mission is to introduce new and emerging asphalt materials and construction technologies to States and industry, which bridges the gap between research and implementation.

MATC Goal:

These technologies and practices are implemented by agencies and industry to provide longer-lasting, safer, better-performing, and more cost-effective asphalt pavements on our nation's highways.

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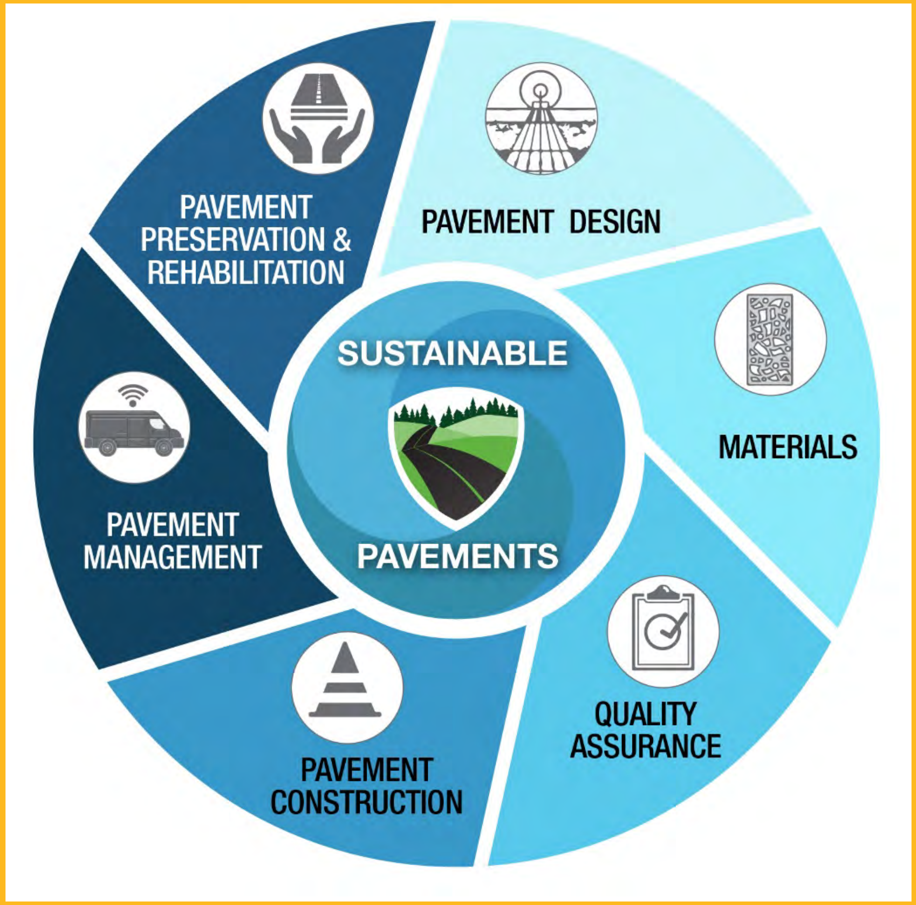
MATC Objectives



- Demonstrate emerging technologies & maintain focus on customer needs
- Deploy technology from TFHRC, Every Day Counts, other research & development (R&D)
- Leverage the asset for whole Pavements program & increase MATC's impact

Core Activities

- Demonstrating test methods and equipment
- On-site support Equipment training
- Case examples developed from innovation trials
- Specification review (QA, materials, construction)
- Equipment loan program

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Deployment

- Quality in Asphalt Paving Workshop: multiday, focused on flexible pavement
- Recorded video briefs: topical to MATC equipment

Level of troubleshooting

- On-site: within scope of standard or agency spec.
- In-depth: direct to FHWA ABML-ID

Post-installed pavement

- Density, sustainability, M&P option selection
- Surface characteristics (macrotexture, etc.)
- Monitoring performance (handheld, other)

MATC Testing Capabilities

Mixture Tests	Materials Tests	Field Tests
AMPT suite of tests (|E*|, cyclic fatigue)	X-Ray Fluorescence Spectrometer for binder's or markings' chemical elements	Paver-mounted thermal infrared for real-time mat temperatures
Overlay Test for reflective cracking	ABT (true grade of binder)	MIT-Scan T3 for in-place pavement thickness
Flexibility index test for fracture resistance	* FTIR looks at molecules in binder (lime, polymers,…)	Circular Track Meter for measuring mean profile depth
IDEAL-CT for crack resistance	* Binder performance testing	Dielectric profiling system for in-place density
IDEAL-RT for rutting resistance	* Done at TFHRC	Laser-based measurement of mean profile depth

Other support activities:
AASHTOWare Pavement™ ME Design analysis

Asphalt pavement specification review

Construction density spec review (mat and joints)

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MATC – Technology Transfer

- Use MATC as a communication vehicle to stakeholders
- Use short communication bursts (1-pagers, social media, etc.) to raise awareness on FHWA efforts
- Current Topics:
  - Enhancing in-place density
  - In the works: Ohio DOT experience with dielectric profiling systems

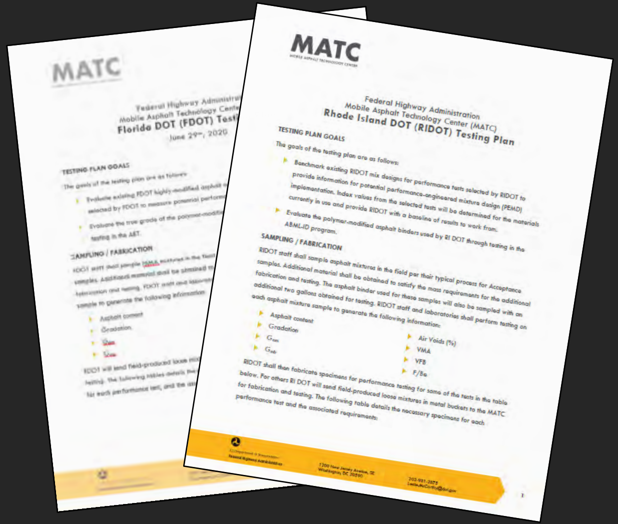
MATC Virtual Support Activities

Technical Assistance
- Specification reviews (SC, VT, RI, FL)
- Performance test analysis (VT, ME)

Testing Plans
- BMD cracking tests (FDOT)
- Macrotexture measuring (FDOT)
- BMD Introduction (RIDOT)
- IDEAL-RT evaluation (MaineDOT)
- I-FIT Round Robin Testing (Caltrans)
- Binder testing & analysis (VTrans)

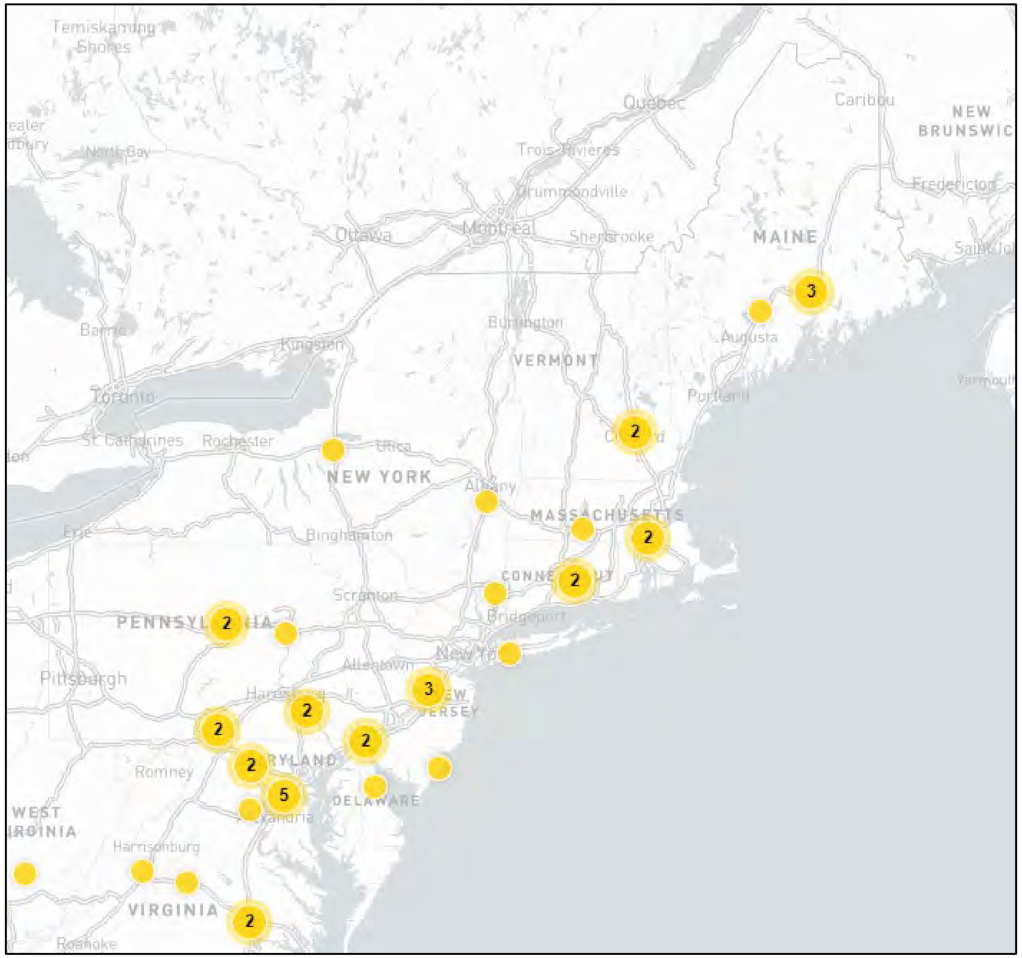
Technology Transfer
- Communication bursts (1-pagers social media, etc.) on FHWA efforts

Marketing Plan
- Social media posts
- New brochure
- Website updates



Ongoing MATC Support to the Northeast

- MATC project visits
  - ME: 2017
  - PA: 2017
  - VT: 2021
- BMD Testing Analysis
  - ME & VT
- Specification Review
  - RI & VT
- Testing Plans
  - RI & VT
- ABML-ID Project Involvement
  - MD, ME, & NH



MaineDOT Data Analysis

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Data Shared by MaineDOT

- Database from multiple years of testing:
  - Ideal Cracking Test (CT_{index})
  - Hamburg Wheel Tracking (rut depth, SIP, NRRI)
  - AMPT – Stress Sweep Rutting (SRI)
  - AMPT - Cyclic Fatigue (S_{app})
  - Volumetric data
- Field produced mix sampled at project site – reheated and tested

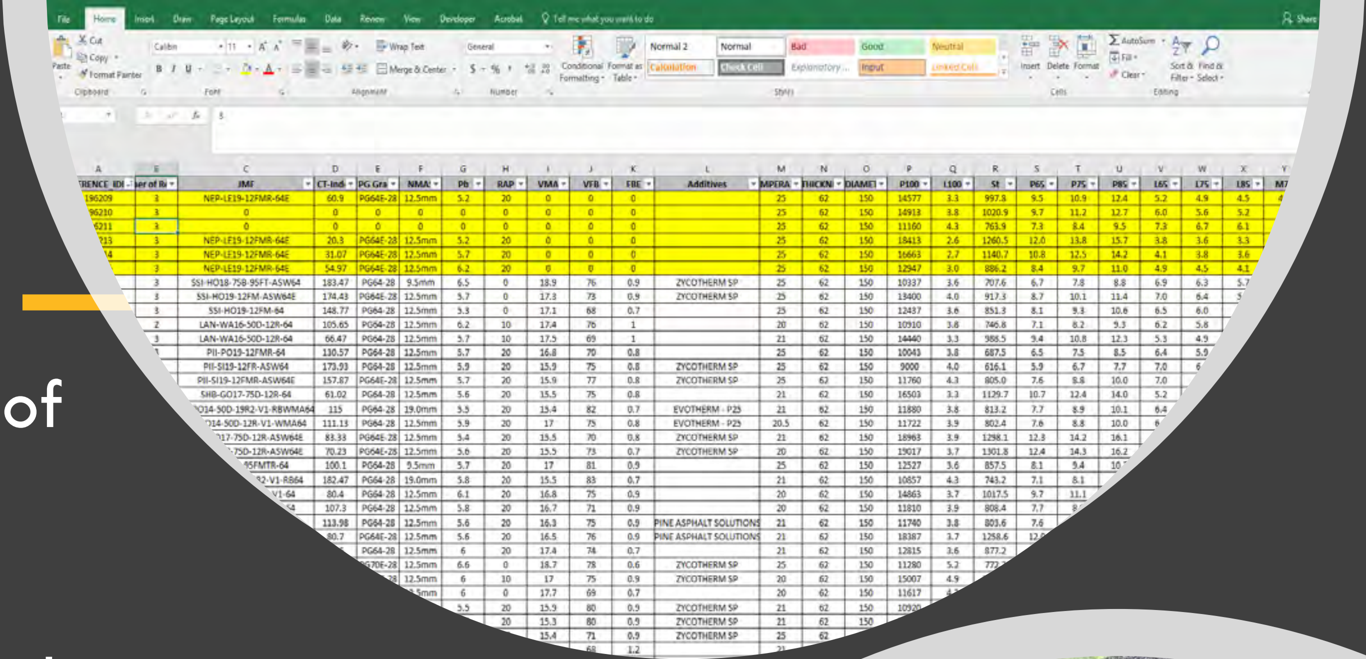


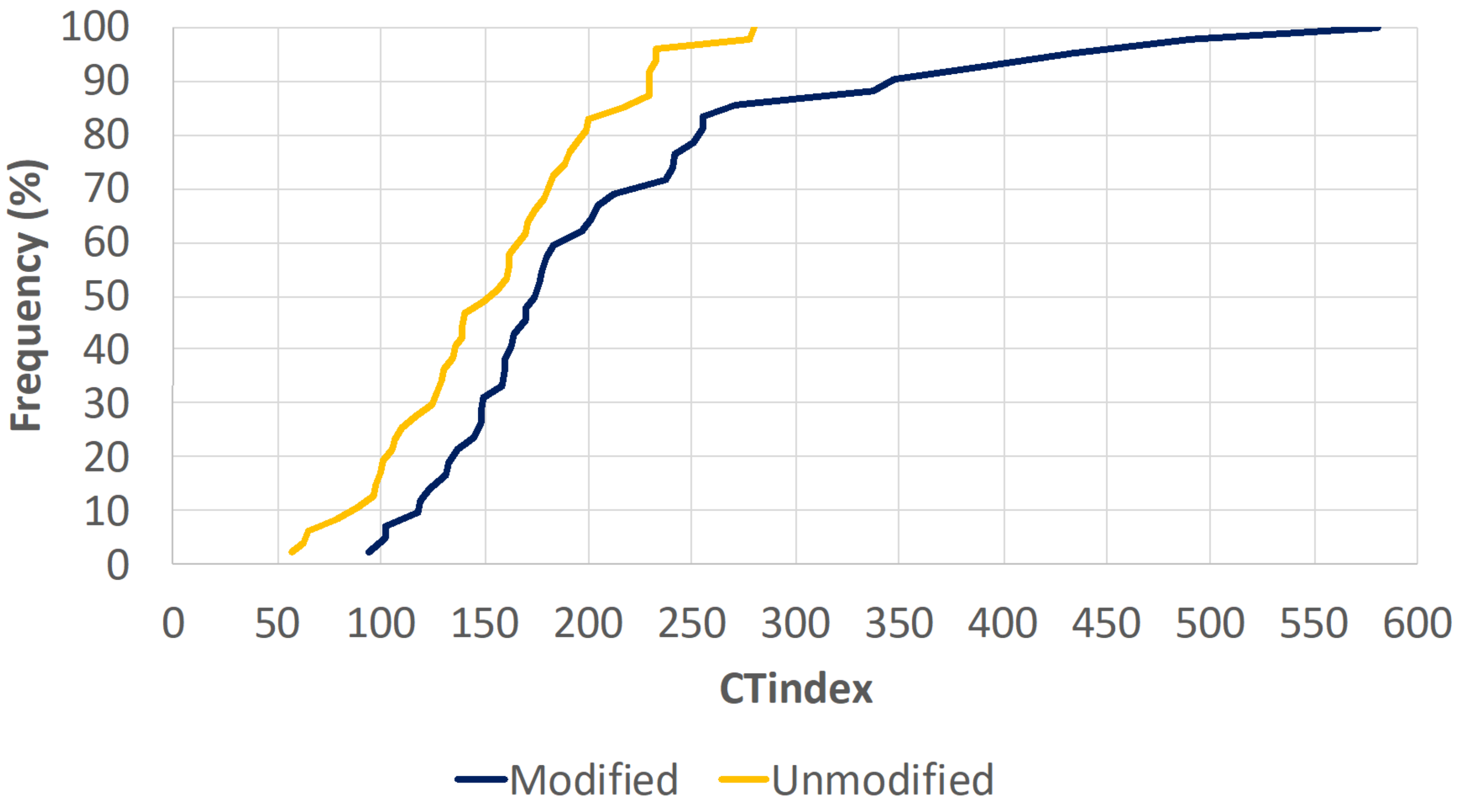
Image source: MaineDOT

MaineDOT Questions

- What are the differences between modified and unmodified asphalt mixtures in Maine?
- How can changes in volumetric properties affect the performance indexes?
- What are the correlations between the performance indexes and field performance of MaineDOT mixtures?

Image source: MaineDOT

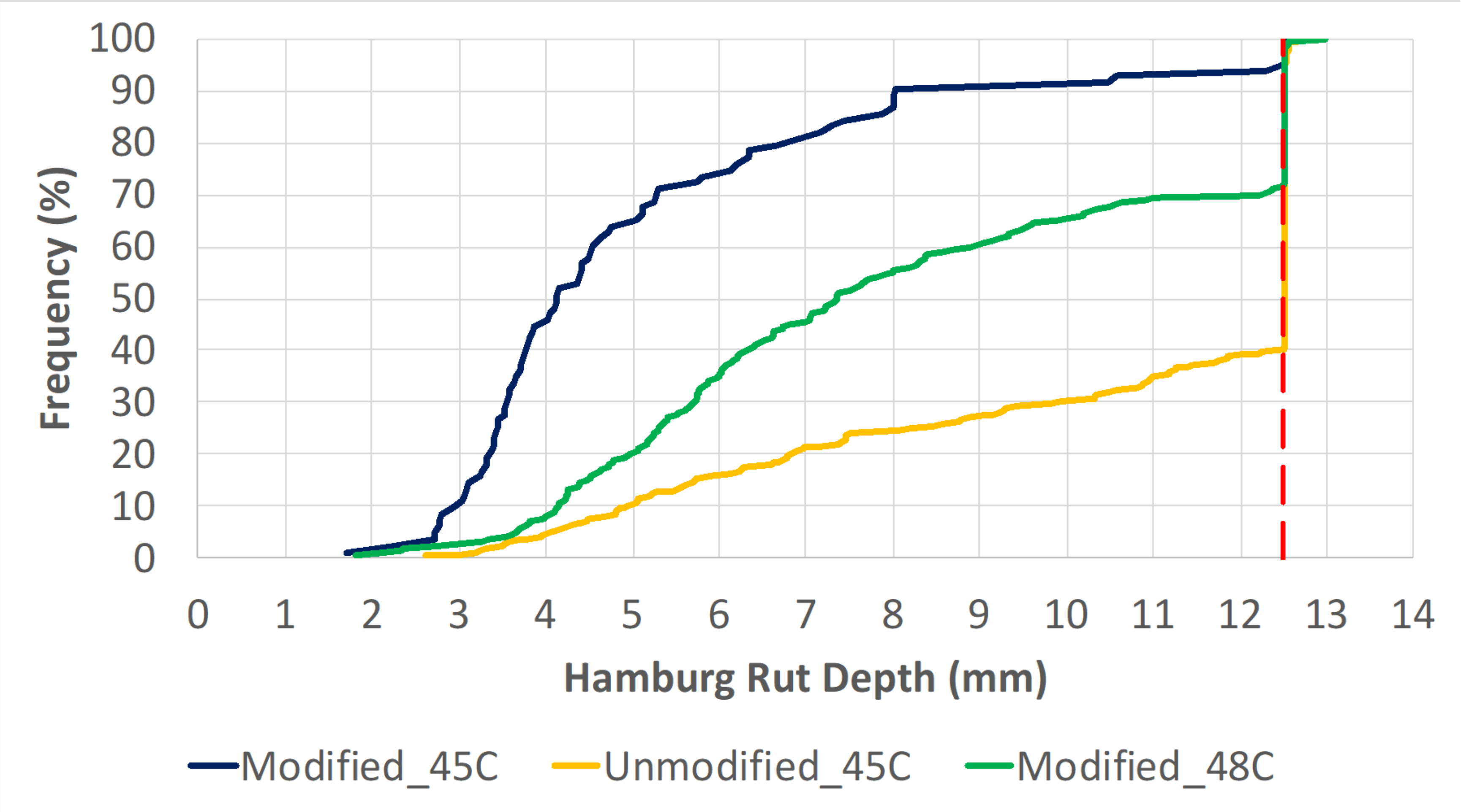
Modified vs. unmodified mixtures @ 25C



MODIFIED			
MEDIAN	AVG	STDEV	COUNT
175.32	210.3	106.1	42

UNMODIFIED			
MEDIAN	AVG	STDEV	COUNT
156.47	155.2	54.4	47

Hamburg Final Rut Depth



MODIFIED @ 45C		
AVG	STDEV	Count
5.2	2.7	83

MODIFIED @ 48C		
AVG	STDEV	Count
8.2	3.4	200

UNMODIFIED @ 45C		
AVG	STDEV	Count
10.4	3.1	263

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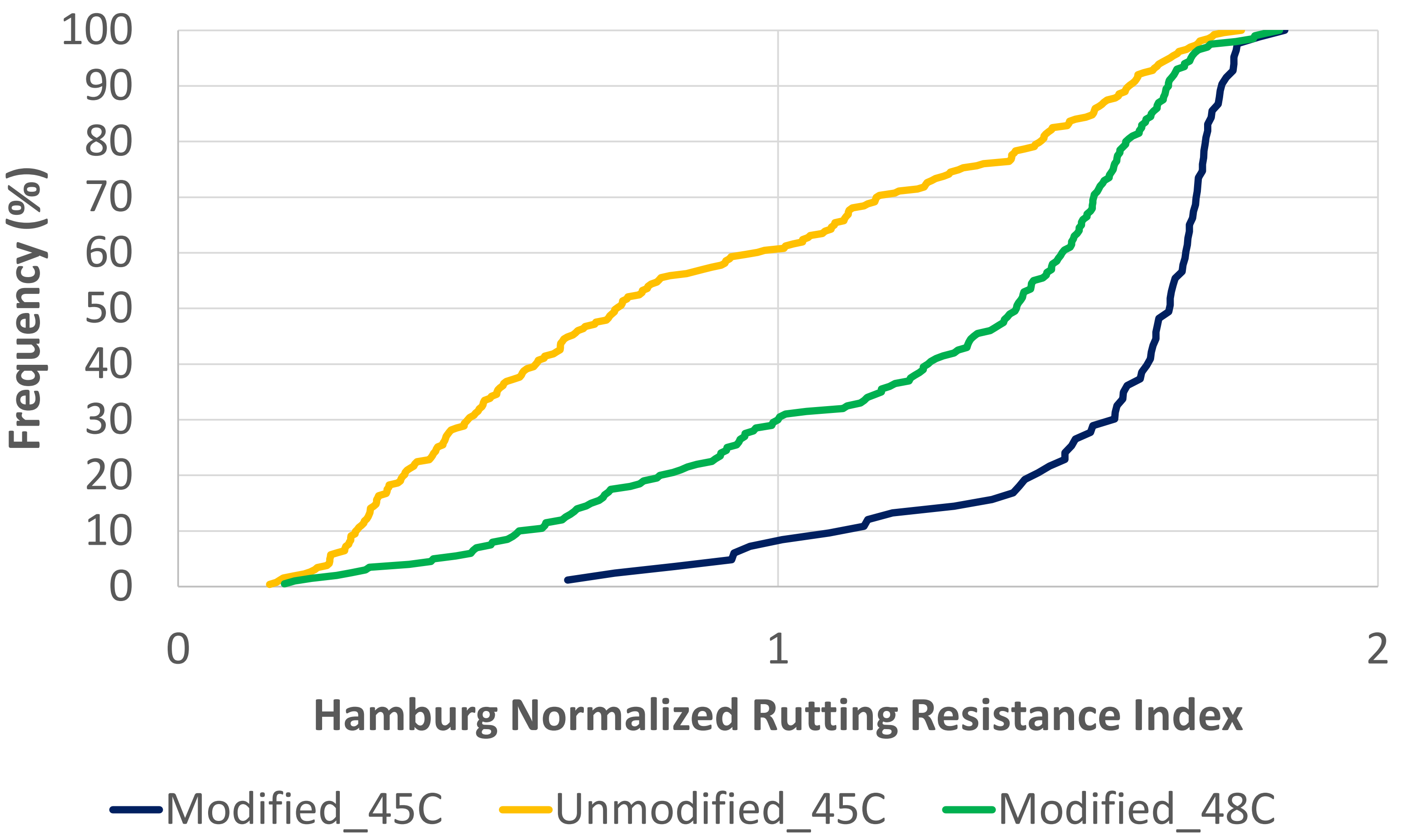
Normalized Rutting Resistance Index (NRRI)



$$RRI = N\ x\ (1 - RD)$$

$N =$ number of passes

$RD =$ final rut depth (inches)

$$NRRI = \frac{Actual\ RRI}{Minimum\ RRI}$$

Minimum RRI = 20000 x (1-0.5")

Minimum RRI = 10,000

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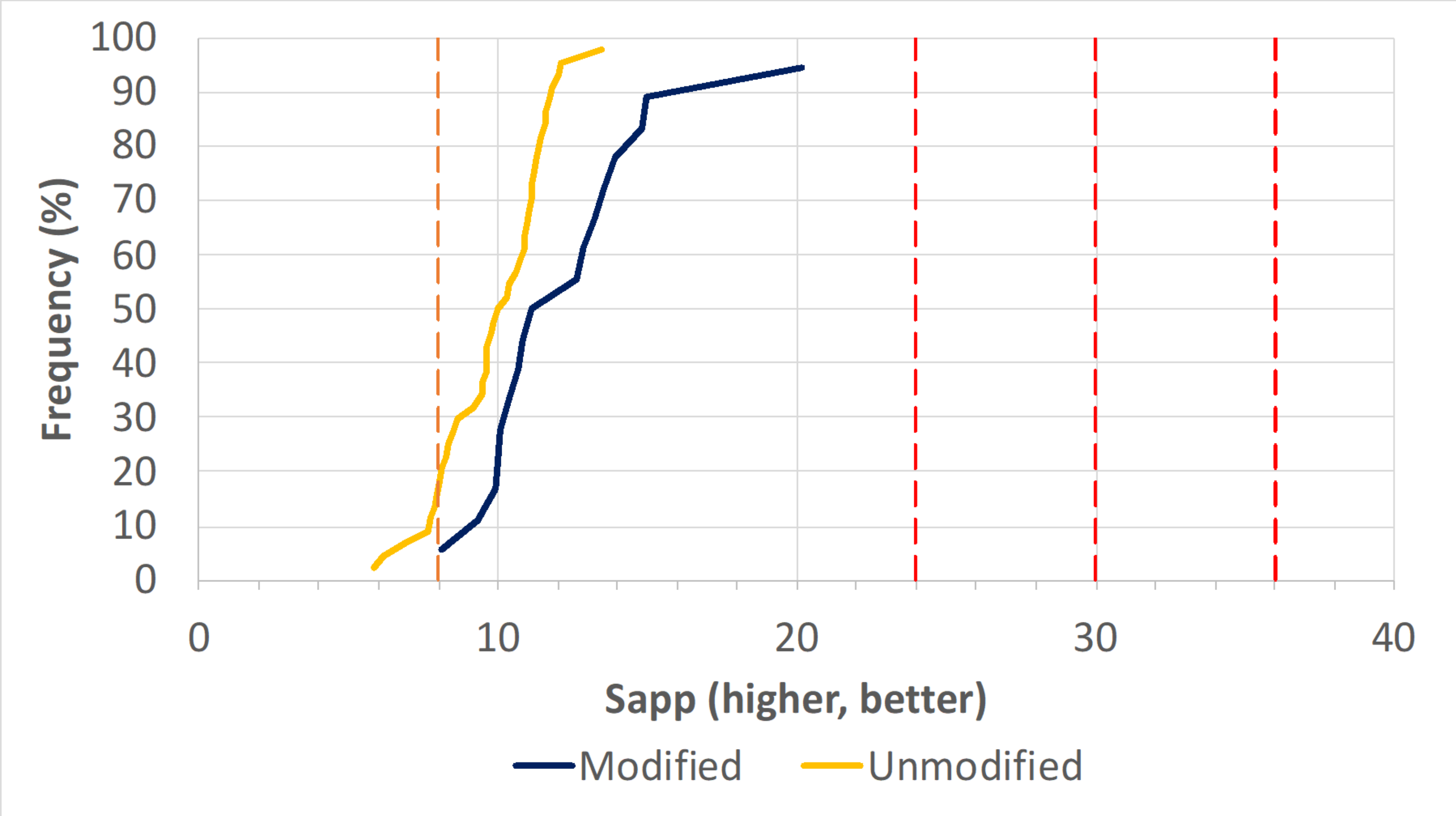
Thresholds of S_{app} and RSI

Traffic (million ESALs)	Limits		Tier	Designation
	S_{app}	RSI		
Less than 10	$S_{app} > 8$	RSI < 12	Standard	S
Between 10 and 30	$S_{app} > 24$	RSI < 4	Heavy	H
Greater than 30	$S_{app} > 30$	RSI < 2	Very Heavy	V
Greater than 30 and slow traffic	$S_{app} > 36$	RSI < 1	Extremely Heavy	E

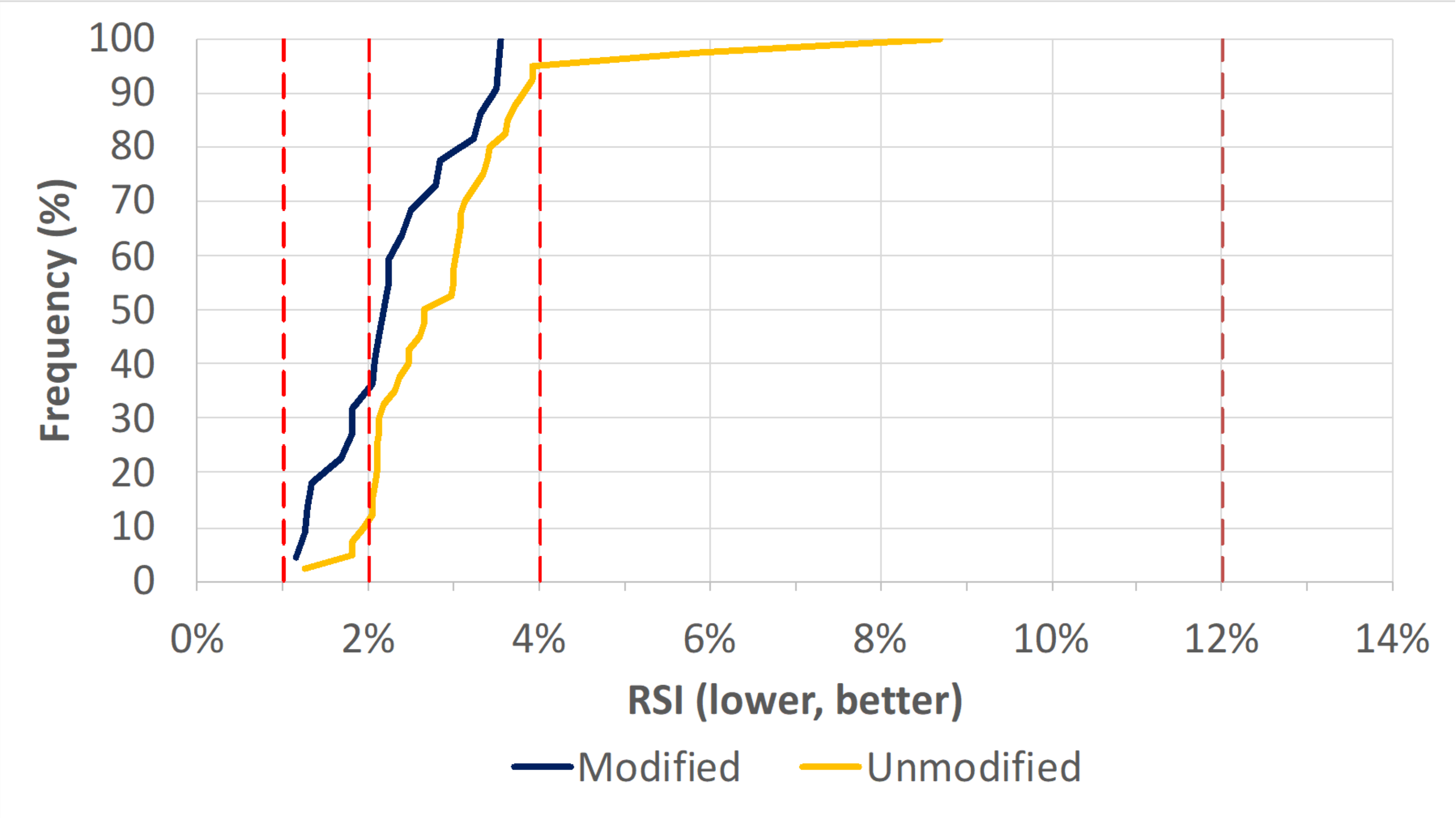
Cyclic Fatigue (S_{app})



MODIFIED @ 48C			
MEDIAN	AVG	STDEV	Count
11.9	12.6	3.51	18

UNMODIFIED @ 48C			
MEDIAN	AVG	STDEV	Count
10.2	10.0	1.86	44

Stress Sweep Rutting (RSI)



MODIFIED			
MEDIAN	AVG	STDEV	Count
2.2%	2.4%	0.76%	20

UNMODIFIED			
MEDIAN	AVG	STDEV	Count
2.1%	3.0%	1.25%	40

MaineDOT Summary

- No relationship between different indices for cracking and rutting
- No clear correlation between volumetrics and index properties on global scale analysis
- Distribution curves show clear improvement in performance testing values with polymer modification
- Differences seen in NMAS and producer
- Continue to investigate correlations between BMD values and field performance

VTrans Data Analysis

Data Shared by VTrans

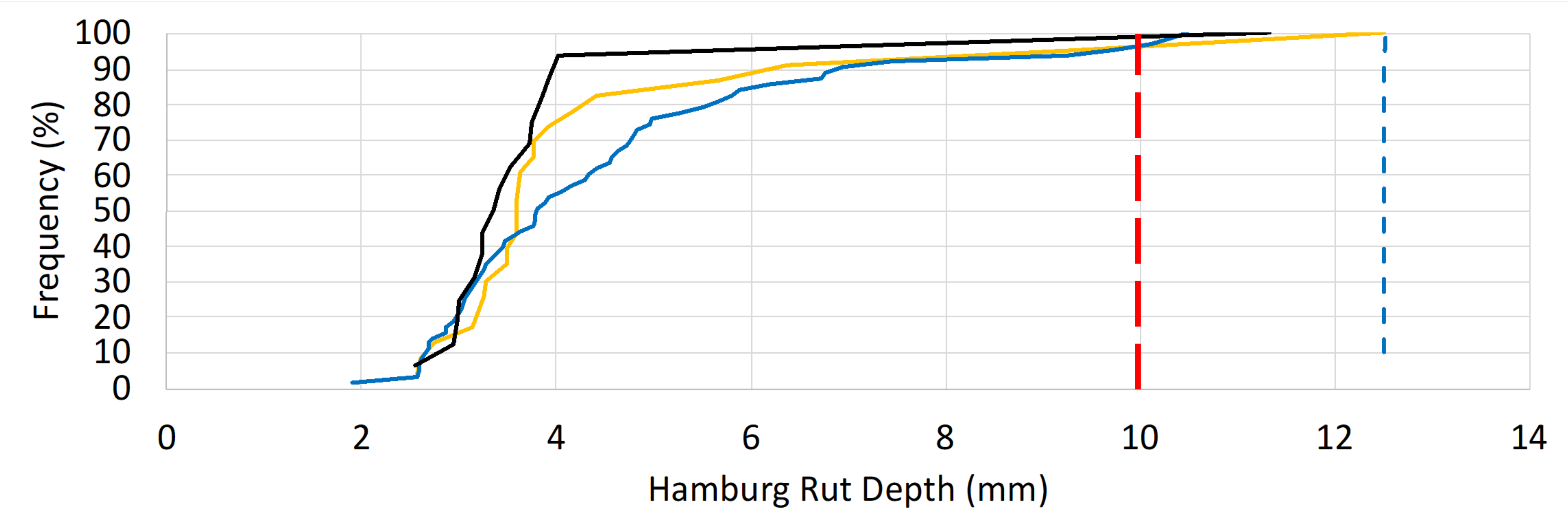
- Database from multiple years of testing:
  - I-FIT (Flexibility Index)
  - Hamburg Wheel Tracking (rut depth, SIP, NRRI)
  - Volumetric data
- Field produced mix sampled at plant site – reheated and tested

Image source: FHWA

VTrans Performance Engineered Mix Design

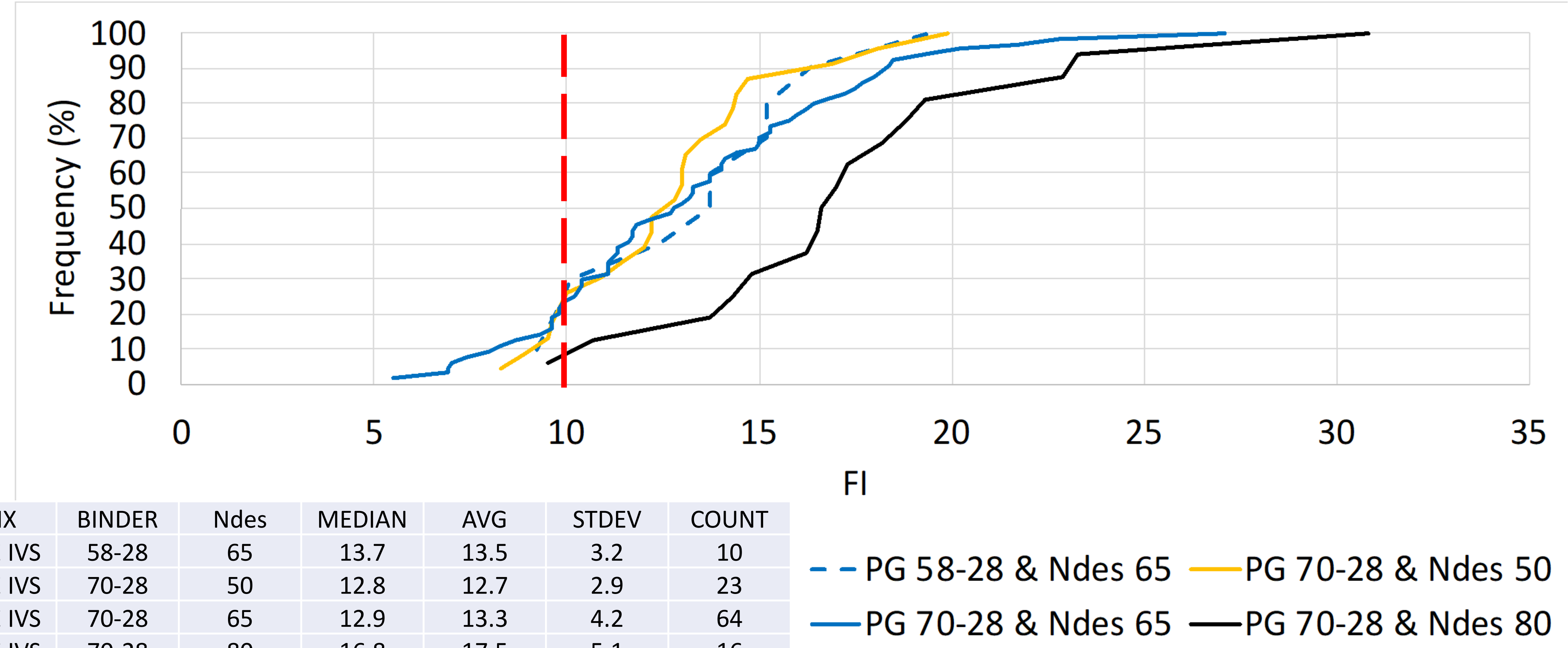
- Superpave Type IVS 9.5-mm mixes
- Hamburg (T 324) criteria @ 45°C and 7.0 ± 0.5 % STA
  - Max average rut depth @ 20,000 passes: 10.0 mm
  - Stripping inflection point (SIP): ≥ 15,000 passes
- Flexibility Index Test (FIT) (TP 124) @ 25°C and 7.0 ± 1.0 % STA
  - Minimum FI: 10.0
- Lot size is completed project
  - Sublot size: 3,000 tons
  - A minimum of 3 sublots needed for statistical evaluation
- Rejectable quality limit (RQL): 60%

HWT Cumulative Distribution for 9.5 mm



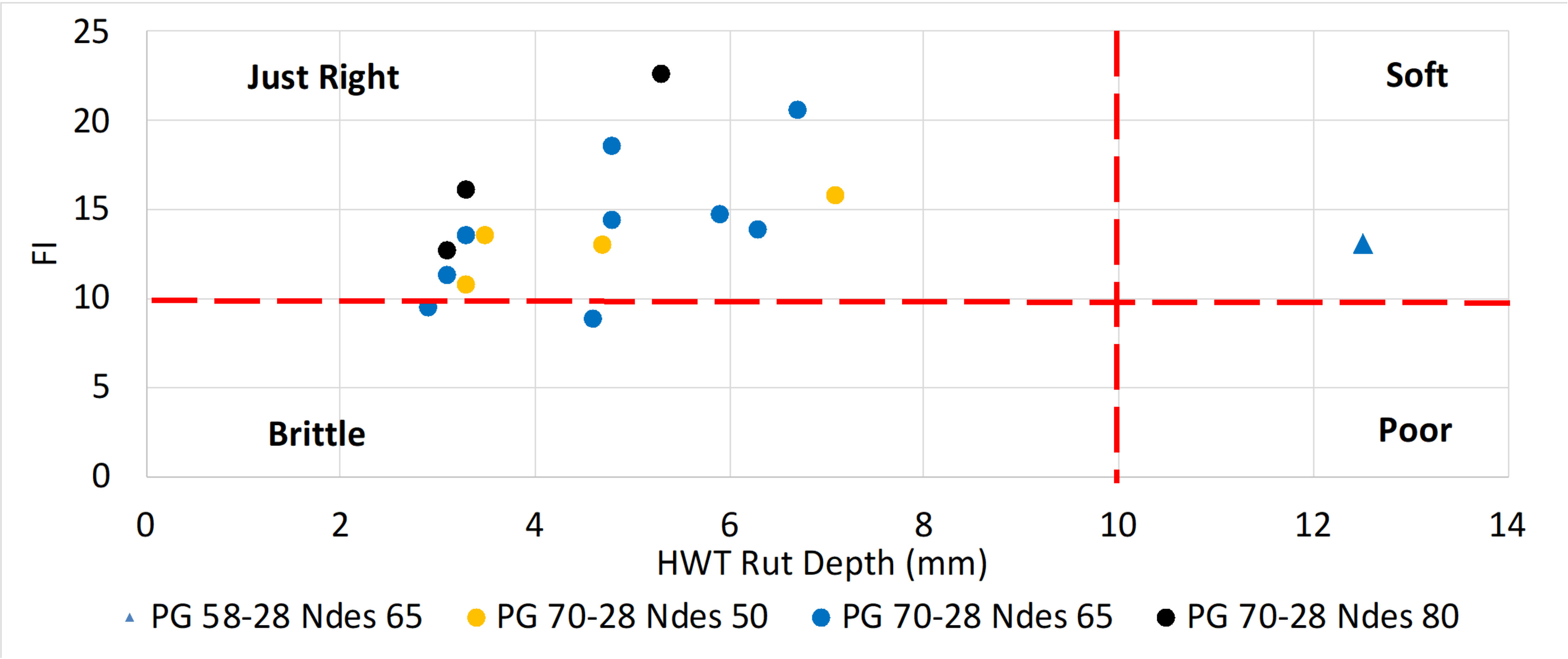
MIX	BINDER	Ndes	MEDIAN	AVG	STDEV	COUNT
TYPE IVS	58-28	65	12.5	12.5	0.0	10
TYPE IVS	70-28	50	3.6	4.3	2.3	23
TYPE IVS	70-28	65	3.8	4.5	2.0	63
TYPE IVS	70-28	80	3.4	3.9	2.0	16

FI Cumulative Distribution for 9.5 mm



MIX	BINDER	Ndes	MEDIAN	AVG	STDEV	COUNT
TYPE IVS	58-28	65	13.7	13.5	3.2	10
TYPE IVS	70-28	50	12.8	12.7	2.9	23
TYPE IVS	70-28	65	12.9	13.3	4.2	64
TYPE IVS	70-28	80	16.8	17.5	5.1	16

Lot Average for Type IVS (≥ 3 Sublots)



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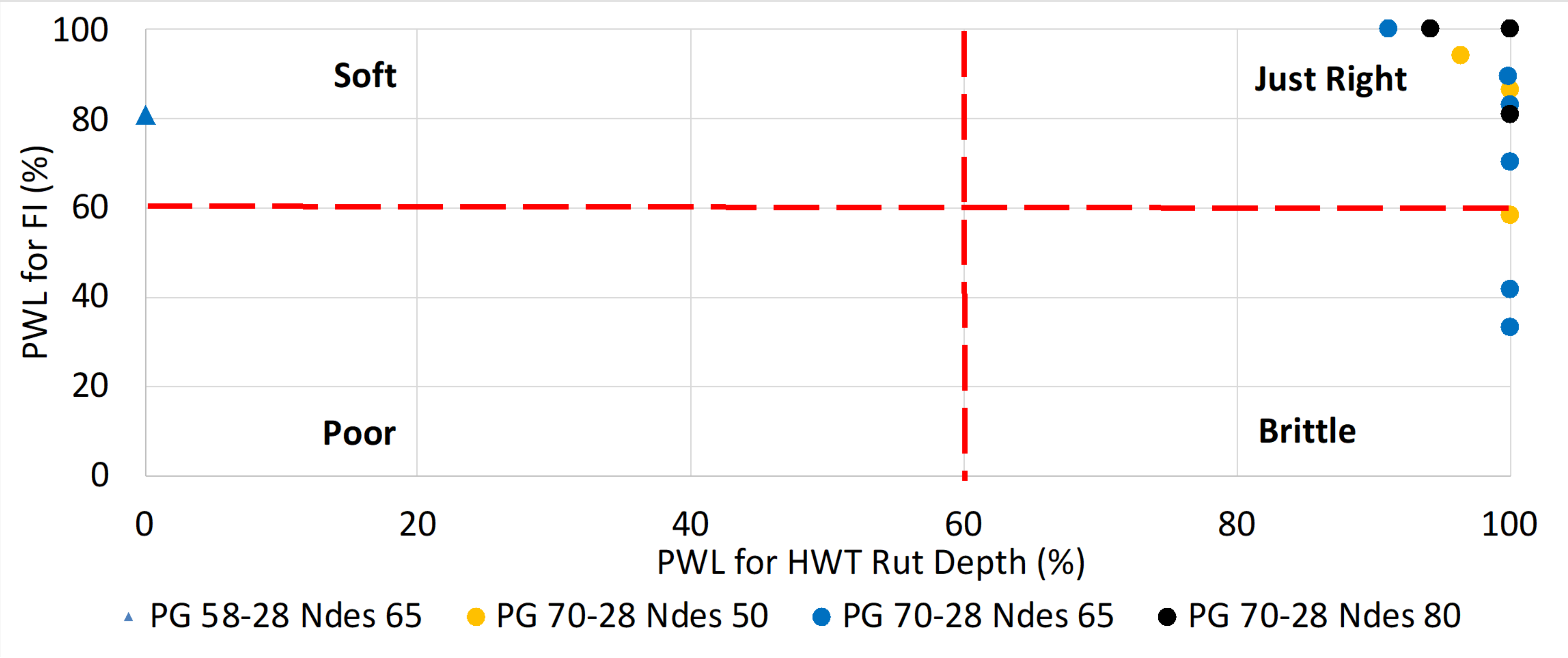
PWL for Type IVS (≥ 3 Sublots)



Statistical Analysis

- Conducted in two steps
  - Step 1 was to determine the effect of the following (specifications) categorical parameters on Hamburg and FI test results
    - Mix type
    - Binder grade
    - Ndes
  - Step 2 was to evaluate the effect of the following volumetric properties on Hamburg and FI test results
    - Air Voids
    - VMA
    - Dust/Binder
    - Ignition Oven AC

Summary of Analysis of Variance ($\alpha = 0.05$)

Effect on average rut depth

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	6	155.843	25.974	7.10	0.000
Mix Type	3	46.624	15.541	4.25	0.012
Binder Grade	1	96.852	96.852	26.48	0.000
Ndes	2	4.881	2.440	0.67	0.520
Error	32	117.024	3.657		
Lack-of-Fit	2	38.404	19.202	7.33	0.003
Pure Error	30	78.620	2.621		
Total	38	272.867			

Effect on average FI

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	6	264.282	44.047	3.29	0.012
Mix Type	3	91.889	30.630	2.29	0.097
Binder Grade	1	1.775	1.775	0.13	0.718
Ndes	2	131.557	65.779	4.92	0.014
Error	32	428.001	13.375		
Lack-of-Fit	2	22.907	11.453	0.85	0.438
Pure Error	30	405.094	13.503		
Total	38	692.283			

Volumetric Effect on HWT & FI

HWT – Rut Depth

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	5	186.91	37.381	14.35	0.000
Air Voids	1	35.94	35.944	13.80	0.001
Mix Type	3	38.24	12.747	4.89	0.006
Binder Grade	1	92.22	92.222	35.40	0.000
Error	33	85.96	2.605		
Lack-of-Fit	20	54.56	2.728	1.13	0.420
Pure Error	13	31.40	2.415		
Total	38	272.87			

I-FIT - FI

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Regression	6	430.29	71.716	8.76	0.000
Air Voids	1	56.16	56.161	6.86	0.013
VMA	1	63.58	63.578	7.77	0.009
Dust/Binder	1	50.61	50.607	6.18	0.018
Ignition AC (%)	1	34.26	34.262	4.18	0.049
Ndes	2	220.94	110.468	13.49	0.000
Error	32	261.99	8.187		
Total	38	692.28			

Summary

- All the mixes tested had good rutting performance based on the Hamburg test results, except…
  - Type IVS mixes with PG 58-28. These mixtures appeared to be sensitive to moisture damage (SIP) in the Hamburg test
- Factors significantly affecting Hamburg Rut Depth
  - Mix type (IIS, IIIS, IVS)
  - Binder grade (58-28, 70-28)
  - Air voids (QC/acceptance air voids)
- Factors significantly affecting FI
  - Ndes (50, 65, 80) with Ndes = 80 resulting in higher FI
  - VBE (= VMA – Air Voids)

What can the FHWA MATC do for you?

- Project Site Visits (Returning in 2021)
- Specification Review
  - Comparison to "Gold Medal Density" States is popular
- BMD Data Analysis
- Technology Transfer
- ABML-ID program
- Equipment Loan Program
- Quality in Asphalt Paving Process Workshop (Coming in 2021)

Contact Us

Derek Nener-Plante, M.S., P.E.

Pavements and Materials Engineer

FHWA Resource Center

derek.nenerplante@dot.gov

202-763-4017

Leslie McCarthy, Ph.D., P.E.

Senior Asphalt Pavement Engineer

FHWA Headquarters

leslie.mccarthy@dot.gov

202-981-2875

Thank you!