SHRP2 SOLUTIONS
STRATEGIC HIGHWAY RESEARCH PROGRAM

Performance Related Specifications (PRS) in the Northeast – Hot Mix Asphalt Perspective

SHRP2 Performance Specifications for Rapid Renewal (R07)

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U.S. Department of Transportation
Federal Highway Administration

American Association of State Highway and Transportation Officials
AASHTO

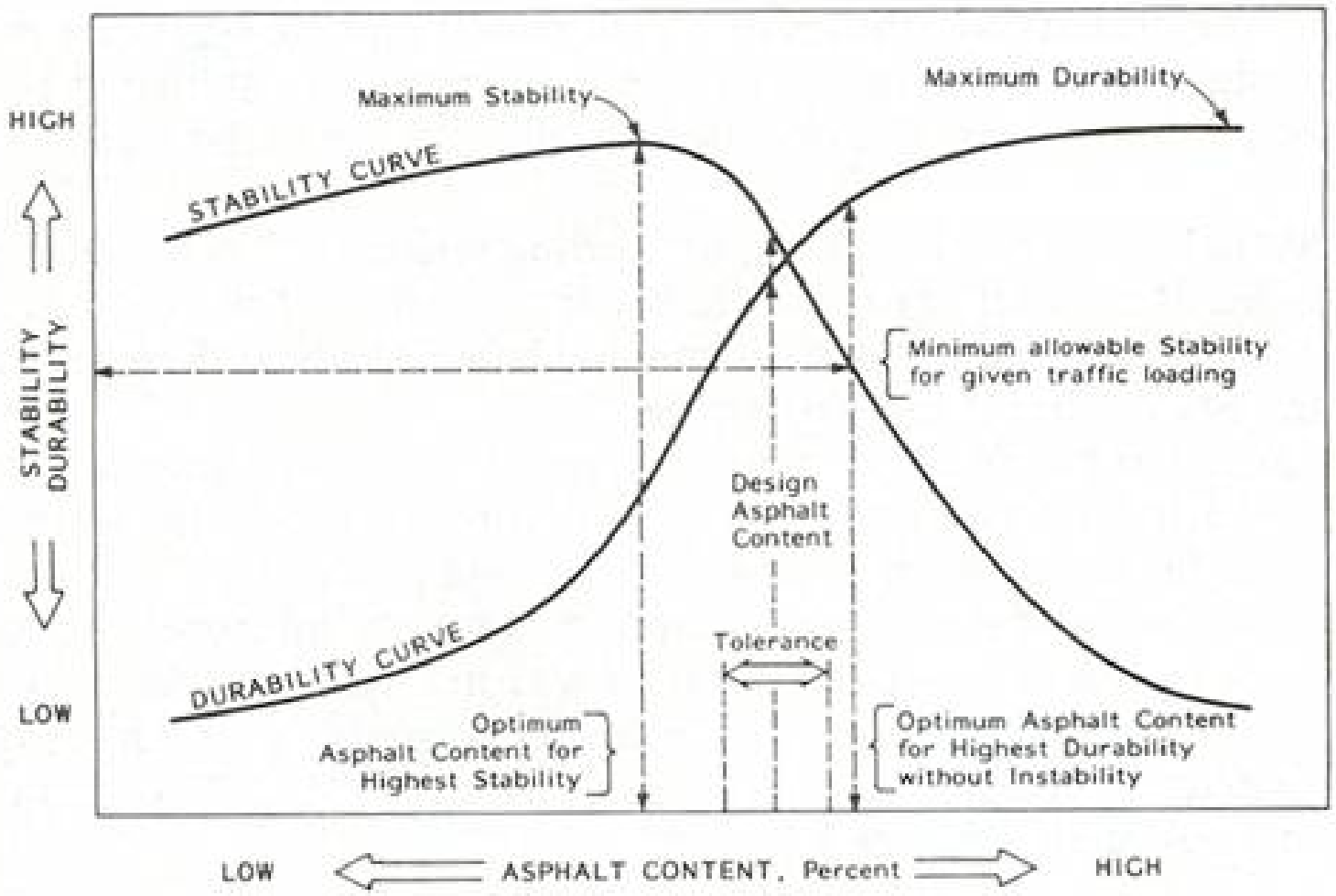
Presentation Overview

- Introduction
- Guideline to Developing Performance Related Specifications (PRS) for HMA
  - Identifying needs
  - Baseline/target development
  - Sampling/Testing Protocols
- Current “Northeast” Practices
- Summary/Conclusions

Why the Need for PRS for HMA?

- Currently a concern among state agencies that current volumetric mixture design does not ensure good field performance
- Depending on climate, traffic, pavement conditions, different state agencies require different levels of performance
  - Not all HMA is created equal
    - New Jersey – rutting, fatigue cracking, reflective cracking
      - Different criteria required for different mix type, location in pavement, and pavement type

Original Intent of HMA Design

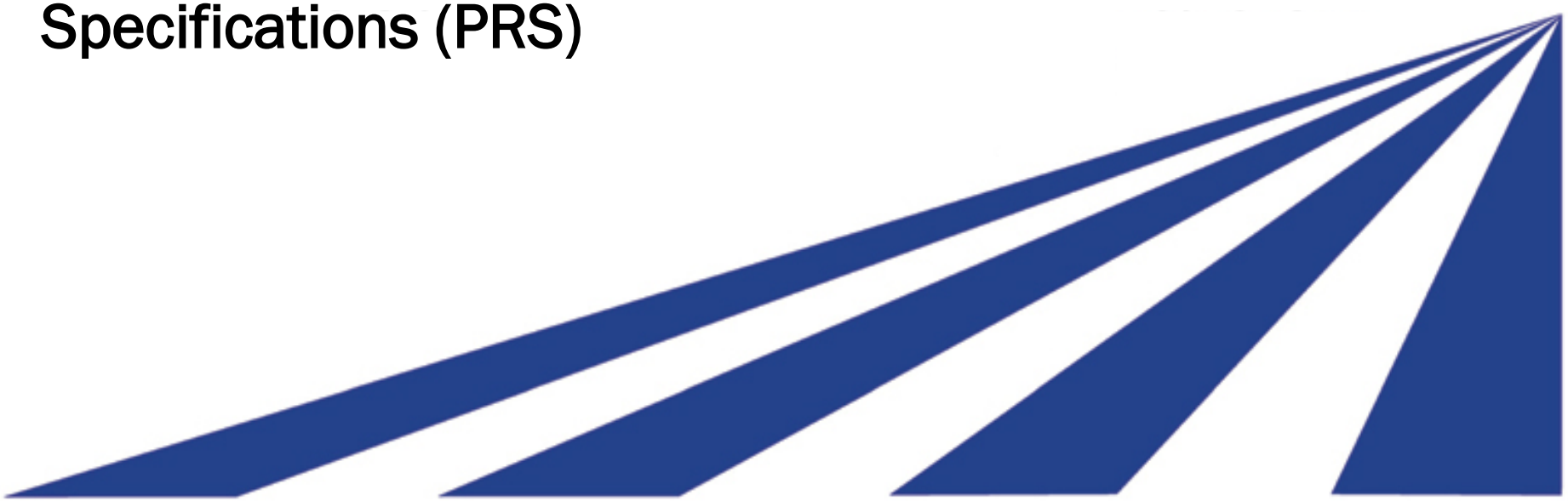


(Hveem, 1940)

Terms (TRB Circular E-C173)

- Performance-Based: Quality Assurance specifications that describe the desired levels of fundamental engineering properties that are predictors of performance and appear in primary prediction relationships
  - Resilient modulus, creep properties, fatigue properties
  - Models that can be used to predict pavement stress, distress, or performance
- Performance-Related: Quality Assurance specifications that describe the desired levels of key materials and construction quality characteristics that have been found to correlate with fundamental engineering properties that predict performance
  - Air voids for HMA; Compressive strength for PCC
  - HMA performance testing(?)

Guideline for Developing Performance Related Specifications (PRS)

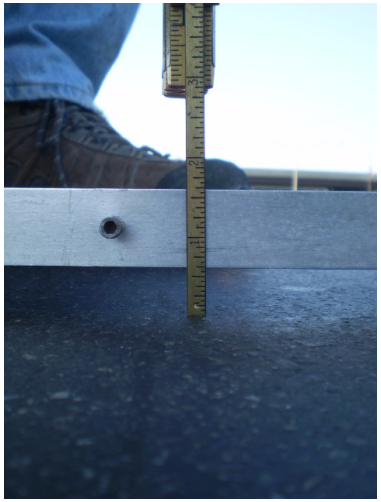


Guidelines for Developing PRS

- Know your pavement performance
- Develop a baseline for performance
- Select an appropriate test procedure
- Develop testing & specification structure
- Go back and re-evaluate

Know Your Pavement

- Important to recognize pavement issues
- Testing methods should try to model distress types found in the field
  - Rutting, fatigue cracking, reflective cracking, thermal cracking
    - Mode of failure should be used in the lab
    - Test temperatures should model climate conditions
- Example:
  - New Jersey: Fatigue Cracking
    - Bridge Deck Mix – uses Flexural Beam fatigue
    - Bituminous Rich Intermediate Course – use Overlay Tester



Develop a Performance Baseline

- How would you like your materials to perform?
  - Historical field data (PMS)
  - Database of material properties
  - Performance criteria should be developed using the performance of local materials
    - Try to avoid “adopting” other state’s specifications when you do not have history of local material performance
- New Jersey Example: High RAP Specification
  - Performance criteria based on virgin (0% RAP) mix
- NYCDOT: HMA Specification
  - Developing performance criteria based on 30% RAP mix (30% RAP is minimum NYC must use)

Select Appropriate Test Procedure

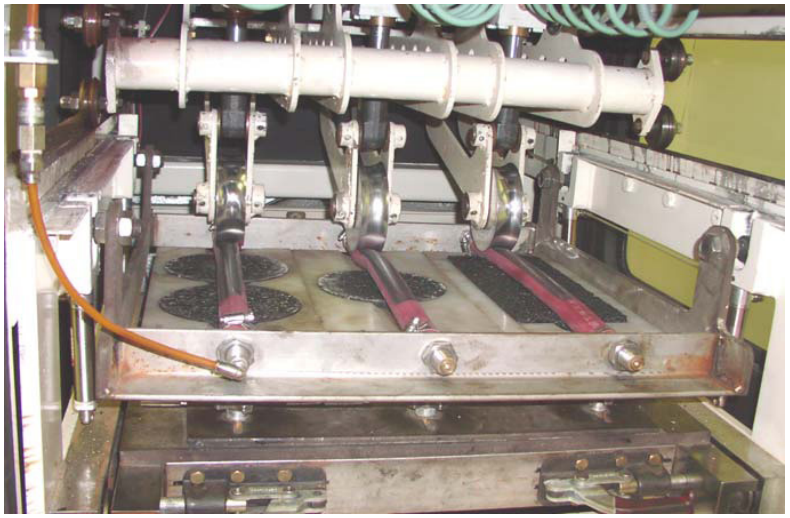
- Priorities of test procedure
  - Correlates to field performance
  - Sensitivity to mixture properties
  - Repeatability
  - Ease of use (procedure, test specimen, time and analysis)
  - Availability/Cost
- NCHRP 9-57 Study – Mixture Cracking Tests

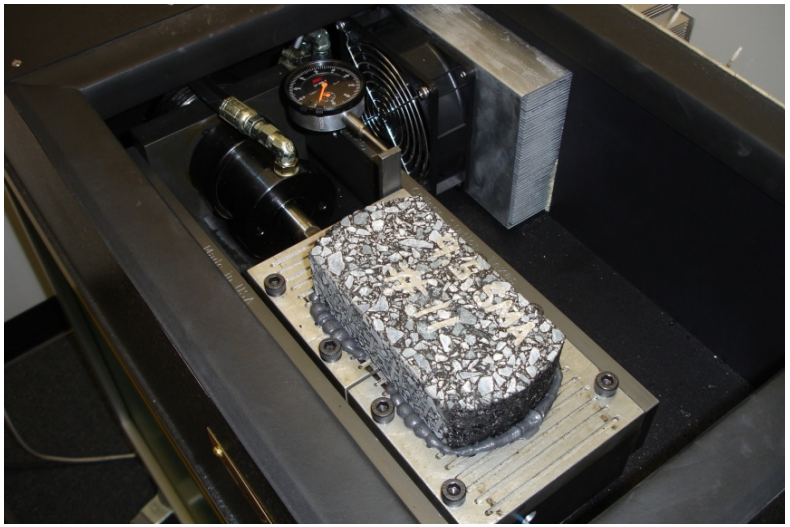
Thermal cracking tests	Reflection cracking tests	Fatigue cracking tests	Top-down cracking tests
1. DCT 2. SCB-IL 3. SCB (AASHTO TP105)	1. OT 2. SCB-LTRC 3. BBF	1. Beam fatigue 2. SCB-LTRC 3. OT*	1. IDT-Florida 2. SCB-LTRC

*OT for fatigue cracking was added later by request of the panel.

Select Appropriate Test Procedure

- Example: New Jersey
  - Rutting: Asphalt Pavement Analyzer (AASHTO T340)
  - Fatigue Cracking:
    - Bridge Decks – Flexural Beam Fatigue (AASHTO T321)
    - BRIC, HRAP – Overlay Tester (NJDOT B-10; TxDOT Tx-248F)
  - Rt 80 in New Jersey
    - 2015 construction
    - NJDOT HPTO mixture
    - Testing indicated 1st 4 nights' production failed rutting criteria





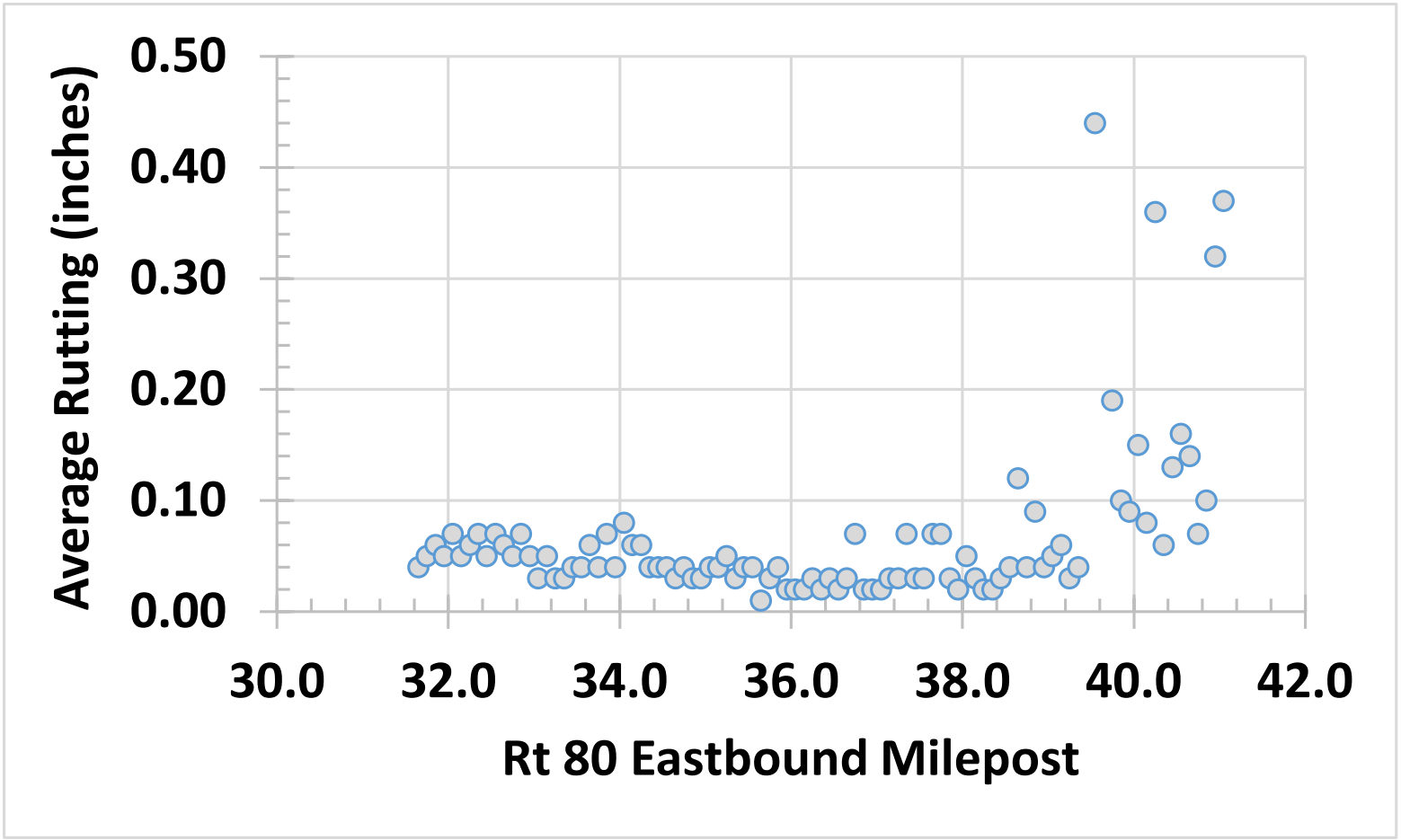
Select Appropriate Test Procedure

- Example: New Jersey HPTO

Date	Original	RTFO	PG Grade	Jnr (1/kPa)	% Rec	MSCR Grade	δ @ 76C (Orig)	δ @ 76C (RTFO)	APA (mm)
5/27/2015	77	76.6	PG76	0.36	59	PG64E	73.6	68.3	6.56
5/28/2015	78.8	78.8	PG76	0.18	72.9	PG64E	69.5	64.5	6.23
5/29/2015	79.6	79.6	PG76	0.17	74.4	PG64E	69.9	64.5	6.5
6/3/2015	78.3	78.7	PG76	0.16	75.5	PG64E	69.6	63.5	6.84
6/4/2015	86.5	79	PG76	0.17	92.4	PG64E	58.9	58.4	3.66
6/5/2015	84.2	78.6	PG76	0.14	77.6	PG64E	65.4	64.8	3.87
6/9/2015	87	81.1	PG76	0.061	89.2	PG64E	60.7	60.1	3.92
6/10/2015	83.7	81.7	PG76	0.1	80.2	PG64E	66	61.8	4.32
6/11/2015	86.3	80.9	PG76	0.051	91.3	PG64E	60.8	58.4	3.98
6/12/2015	82.4	81.2	PG76	0.048	91.3	PG64E	66.8	60.4	3.73
6/17/2015	87.5	81.8	PG76	0.046	92.2	PG64E	60.6	57.9	3.83
6/18/2015	87.6	82.6	PG82	0.041	92.4	PG64E	61.2	59.2 @ 82C	2.94
6/19/2015	86.5	82.3	PG82	0.041	92.4	PG64E	59.2	59.2 @ 82C	2.73
6/24/2015	83.8	79.5	PG76	0.074	89.1	PG64E	62	59.7	3.99

Select Appropriate Test Procedure

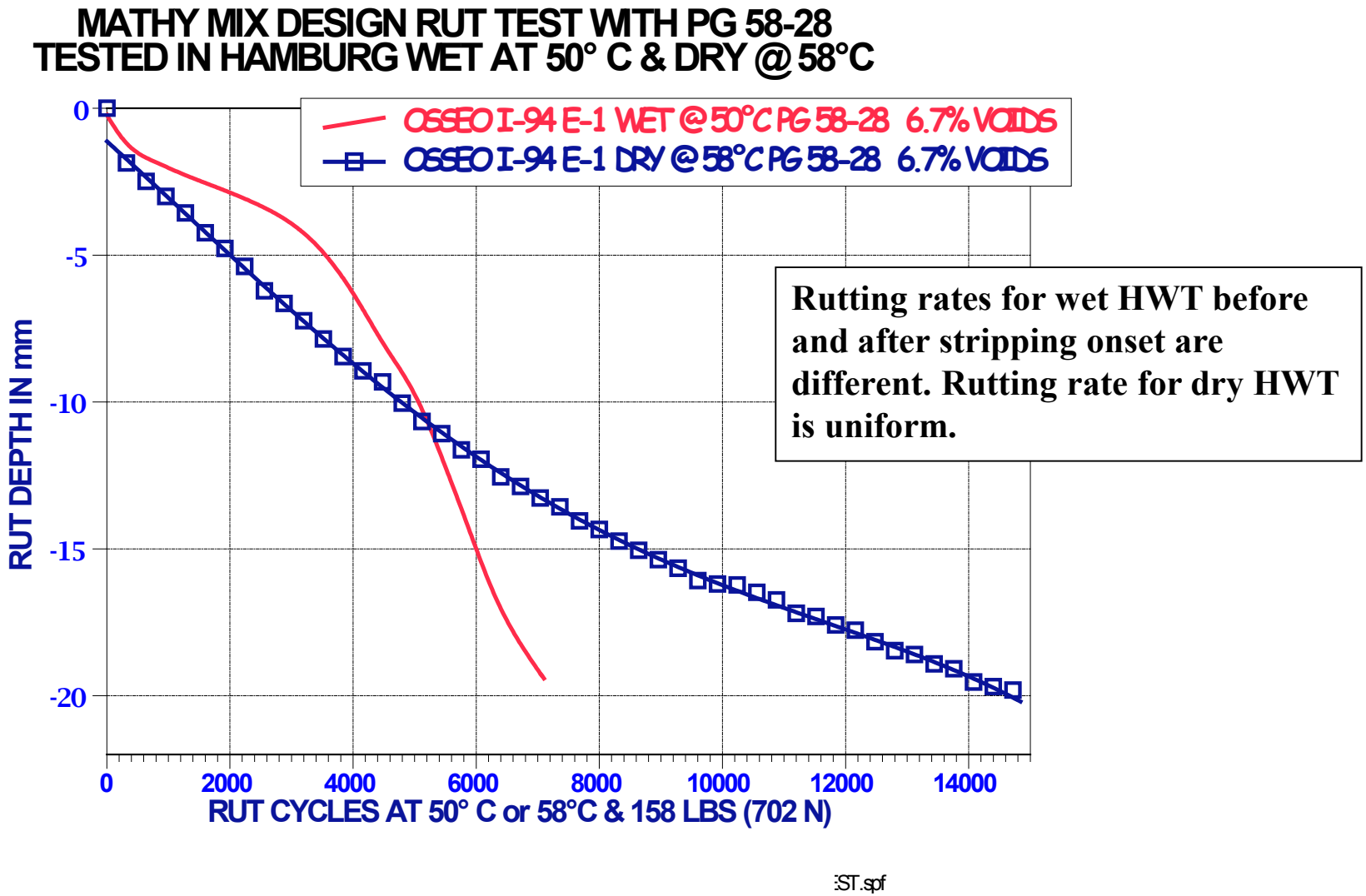
- Example: New Jersey HPTO
  - PMS Test Data – Collected July 2016



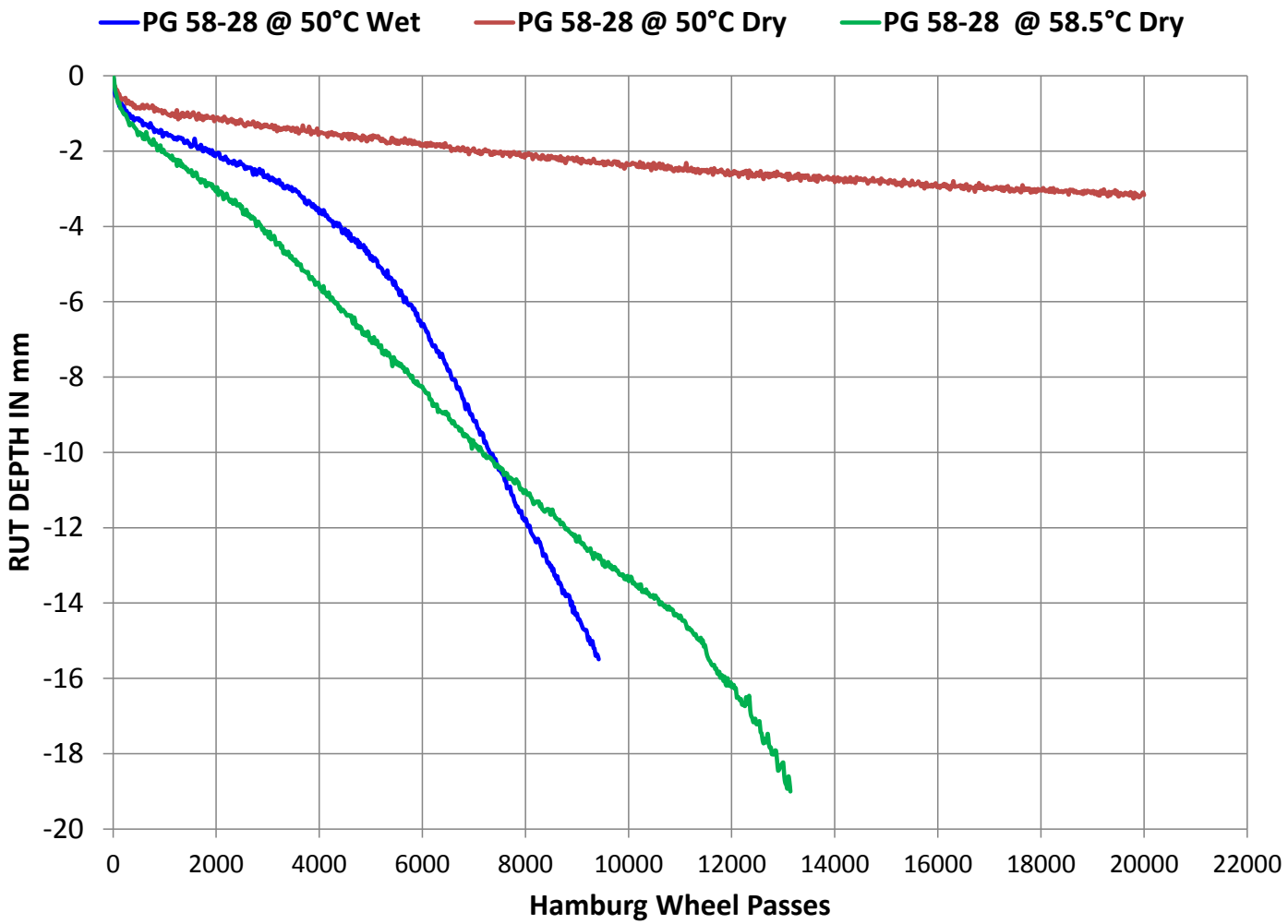
Select Appropriate Test Procedure

- Be careful of adopting test methods and criteria developed by other agencies
  - Should you consider a rutting and fatigue cracking to "balance" performance?
- Be careful of selecting test procedures where results may be dependent on multiple failure mechanisms
  - Example: Hamburg Wheel Tracking (TxDOT) for rutting
    - Running test under couples stripping and rutting – which mode of distress dominates?

Select Appropriate Test Procedure



Select Appropriate Test Procedure



Develop Specification Structure

- Stage of testing
  - Should it be included during mix design? Test strip? QC/QA?
- Frequency of testing
  - Lot, night's production?
  - Keep in mind time requirements of the test method
- Responsible testing laboratory
  - State lab, consultant, university partner, asphalt plant under state inspection
- Handling failing results
  - Remove/replace, pay adjustment, stop production to adjust mix

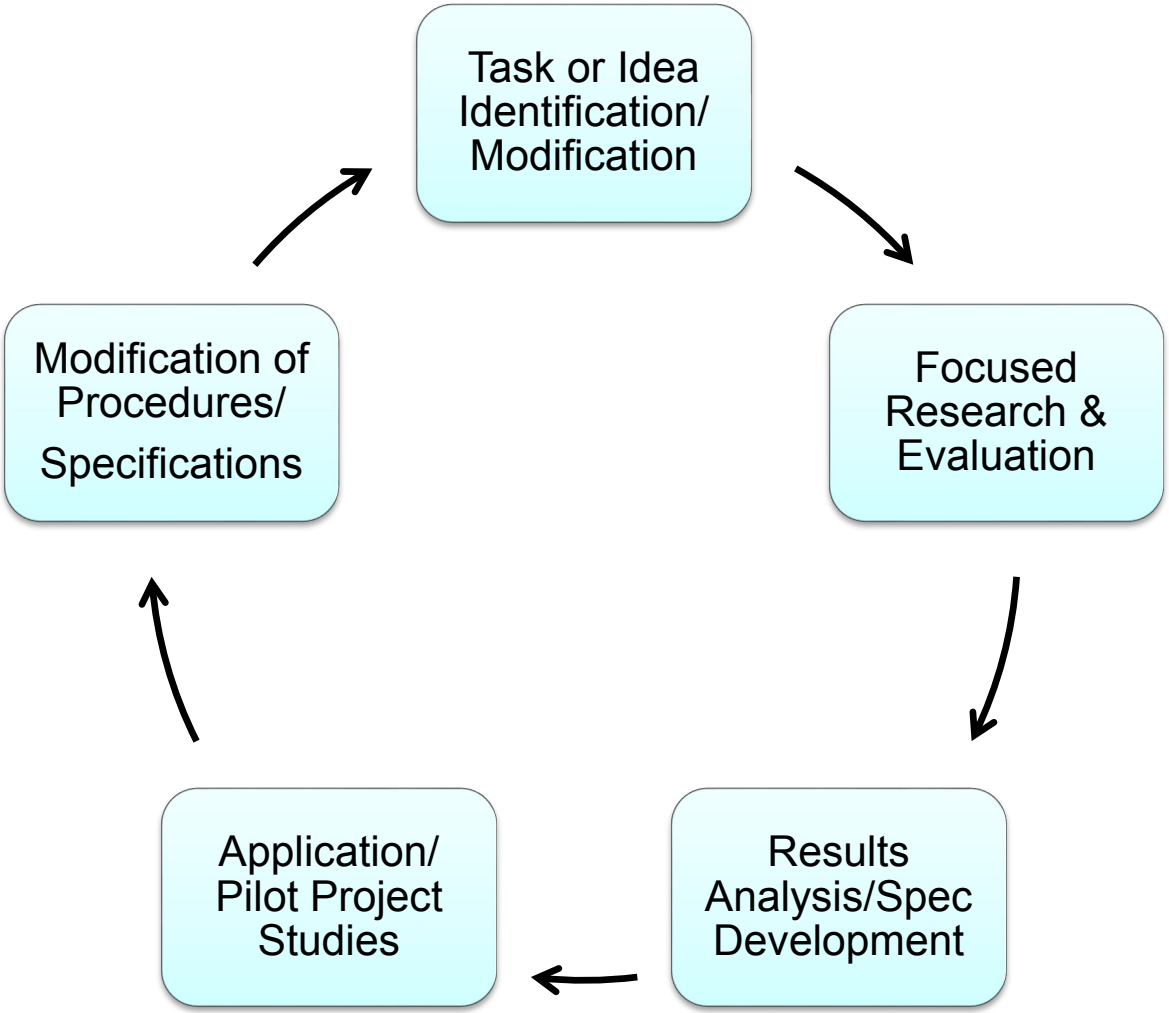
Develop Specification Structure

- Example: New Jersey
  - Testing conducted;
    - During mix design, required test strip, 1st and every other Lot
      - Small production quantities are tested once per night production
  - Testing laboratory;
    - Up until 1/2016 – University Partner (Rutgers University – AMRL Accredited)
    - 1/2016 – Present – NJDOT Central Laboratory
      - Rutgers helped to install equipment and provide training on sample fabrication, testing, and analysis
  - Handling failing results
    - Mix design – must conduct redesign until passes
    - Test strip – must conduct another test strip until passes
    - Mainline – pay adjustment (negative only at this time)

Develop Specification Structure

Table 902.11.04-2 Performance Testing Pay Adjustments for HMA HIGH RAP					
	Surface Course		Intermediate Course		PPA
	PG 64-22	PG 76-22	PG 64-22	PG 76-22	
APA @ 8,000 loading cycles, mm (AASHTO T 340)	$t \leq 7$ $7 > t > 10$ $t \geq 10$	$t \leq 4$ $4 > t > 7$ $t \geq 7$	$t \leq 7$ $7 > t > 10$ $t \geq 10$	$t \leq 4$ $4 > t > 7$ $t \geq 7$	0 – 1 – 5
Overlay Tester, cycles (NJDOT B-10)	$t \geq 150$ $150 > t > 100$ $t \leq 100$	$t \geq 175$ $175 > t > 125$ $t \leq 125$	$t \geq 100$ $100 > t > 75$ $t \leq 75$	$t \geq 125$ $125 > t > 90$ $t \leq 90$	0 – 1 – 5

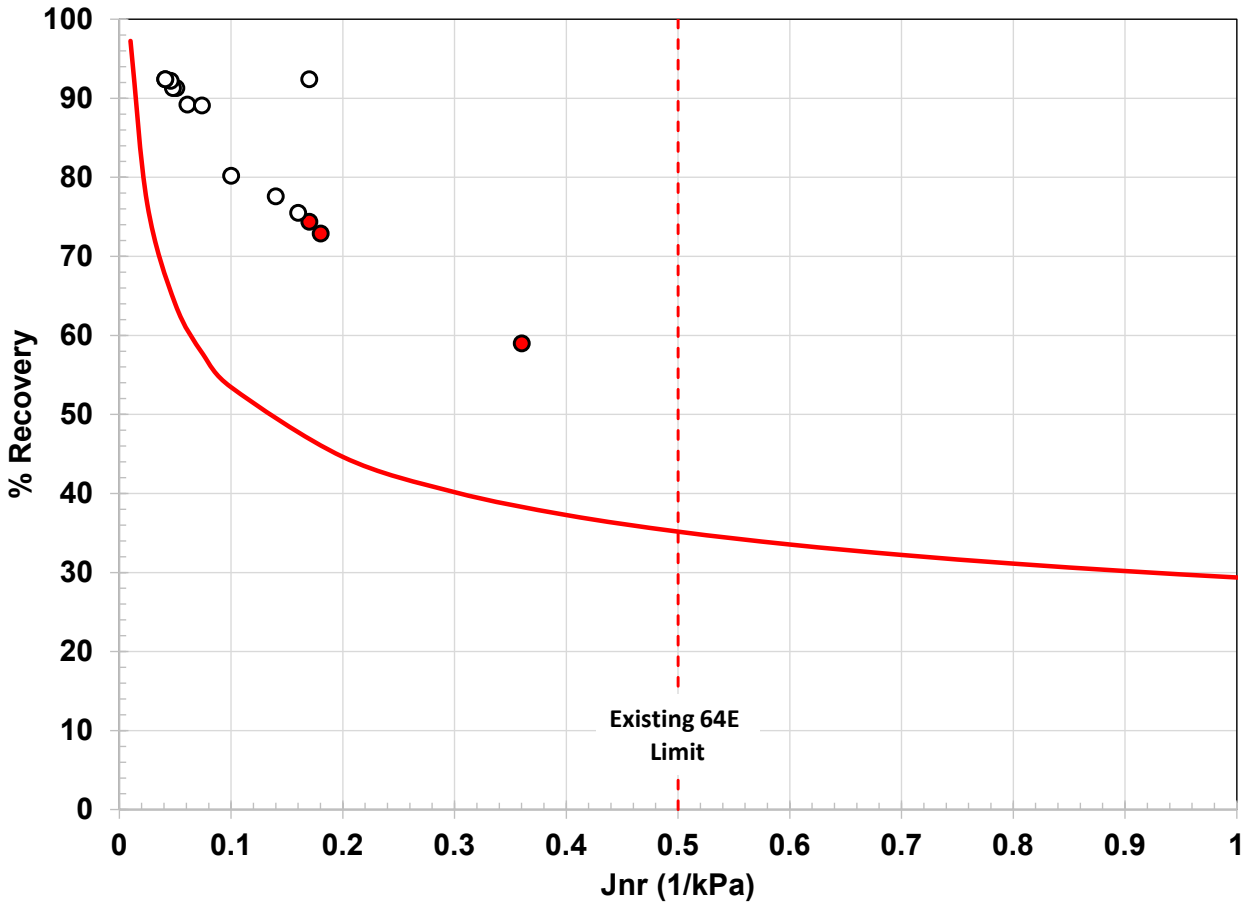
Go Back and Re-evaluate



Go Back and Re-evaluate

2015 HPTO – retained binder samples

- Need to re-evaluate asphalt binder specification for HPTO?



Current “Northeast” State Performance Related Specifications

Northeast Survey

- Brief email survey sent out to “Northeast” states regarding current/potential use of PRS
  1. Is your state using PRS, and if so, at what level?
  2. Who conducts the testing?
  3. What pavement distresses are you concerned with?
  4. What performance tests are you using?
  5. What types of asphalt mixtures are you using PRS?
- States responding
  - 8 Northeast (CT, DE, NH, NJ, NY, PA, RI, VT) + Missouri

Northeast Survey

- At what level is your state using PRS?
  - 2 states using/developing PRS solely for mixture design acceptance
  - 1 state using/developing PRS for mixture design and Quality Acceptance
  - 2 states using/developing PRS for quality acceptance
  - 2 states still working on PRS
  - 2 states not interested at the moment

Northeast Survey

- Who is/would be responsible for testing within your PRS?
  - 3 states using solely their agency laboratory
  - 1 state combining agency and consultant services
  - 2 states combining agency and university partner
  - 1 state requiring contractor to hire accredited laboratory

Northeast Survey

- What pavement distresses are you most concerned with?
  - Fatigue cracking (7 states)
  - Thermal cracking (6 states)
  - Rutting (5 states)

Northeast Survey

- What performance tests are you using/considering using?
  - Rutting
    - Hamburg Wheel Tracking: 3 states
    - Asphalt Pavement Analyzer: 2 states
    - AMPT Flow Number: 1 state
  - Fatigue cracking
    - Semi-circular Bend (SCB): 3 states
    - Overlay Tester: 2 states
    - Flexural Beam Fatigue: 2 states
  - Thermal cracking
    - Disc Compact Tension (DCT): 1 state

Northeast Survey

- What performance tests are you using/considering using?

Mix Design		Quality Control	
Rutting	Flow Number	Rutting	Hamburg
	APA		APA
	Hamburg		
Fatigue Cracking	Flexural Beam	Fatigue Cracking	Flexural Beam
	Overlay Tester		Overlay Tester
	SCB		SCB
Thermal Cracking	N.A.	Thermal Cracking	DCT

Northeast Survey

- What types of asphalt mixtures are you concentrating PRS on?
  - Specialty mixes (High RAP, Bridge Deck, etc): 3 states
  - High traffic volume: 1 state
  - When job requires > 6000 tons: 1 state
  - All HMA: 1 state

Summary/Conclusions

- HMA volumetrics do not tell the whole story
  - Used as a surrogate for actual performance testing
  - Increased use of polymers, WMA, recycled binders can change performance without changing volumetrics
- PRS/PBS can provide confidence to state agencies that HMA designed and produced will perform to a required level
- Many layers within PRS/PBS that agencies must consider
  - Not a one size fits all. Agencies need to develop specifications that best works for their traffic, pavement, and climate conditions

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Thank you for your time!

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