Louisiana's Balanced Asphalt Mixture Design

Samuel Cooper III , Ph.D., P.E.
Materials Research Administrator
Louisiana Department of Transportation and Development

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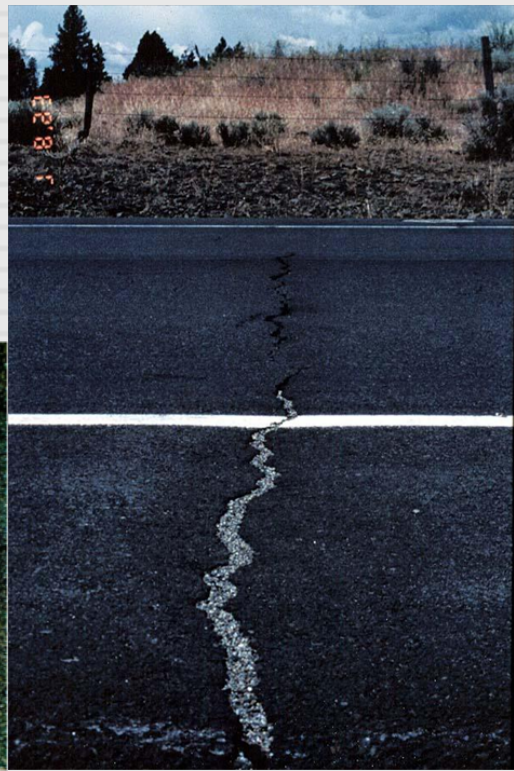
The Process – What we Did.

- 4 years post implementation now!
  - Years of forensic investigation and research
    - LTRC Asphalt Research Group, LADOTD Materials Lab, EMCRF, Louisiana HMA Producers
  - Pilot Specification Development
  - Pilot Program/Field Trials
  - Practical Adjustments
  - Industry Buy-in
  - Training

Introduction

- LADOTD's conventional design practice were not capturing performance
- Increases in recycled material content
- Methods to evaluate mixture performance indicators
  - Determine Asphalt Quality vs Quantity

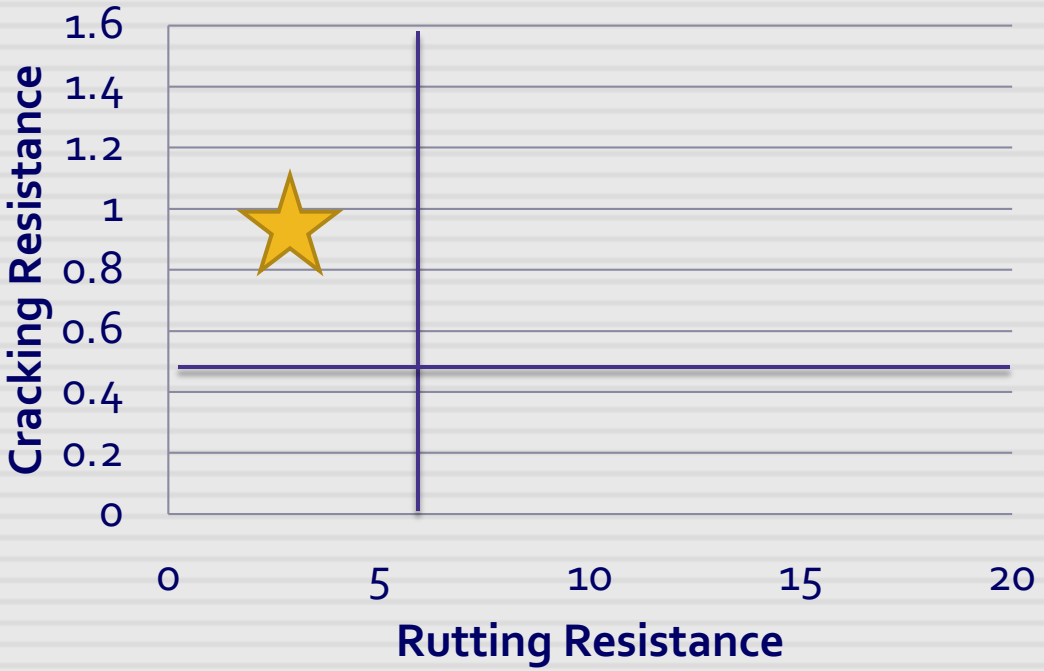


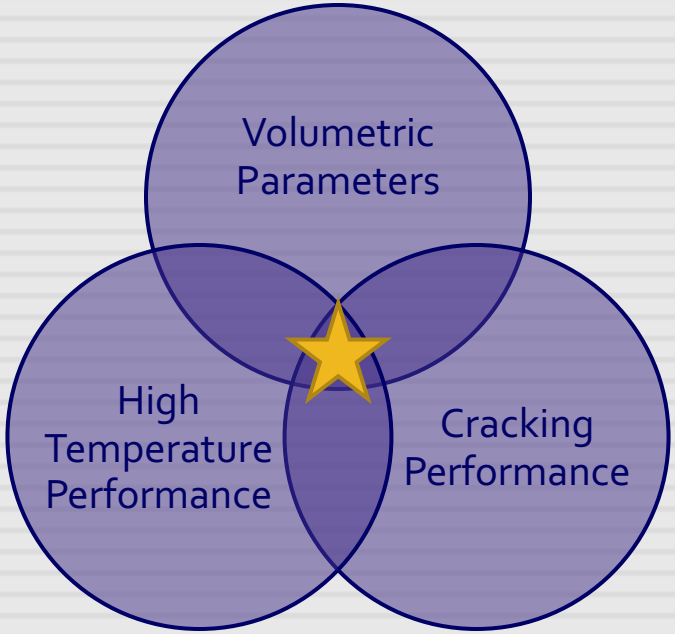
How can we determine binder quality in mixtures?

- Laboratory tests to evaluate the as-built pavement qualities.
- The test will screen materials prone to rutting, cracking and alternative moisture damage indicators.
  - Create a **Balanced Mixture Design**

Complement Volumetric Mixture Design with Testing

- What is a balanced mixture design?
  - Process to ensure adequate resistance to both rutting and cracking distresses
- Laboratory testing:
  - Rutting and Cracking





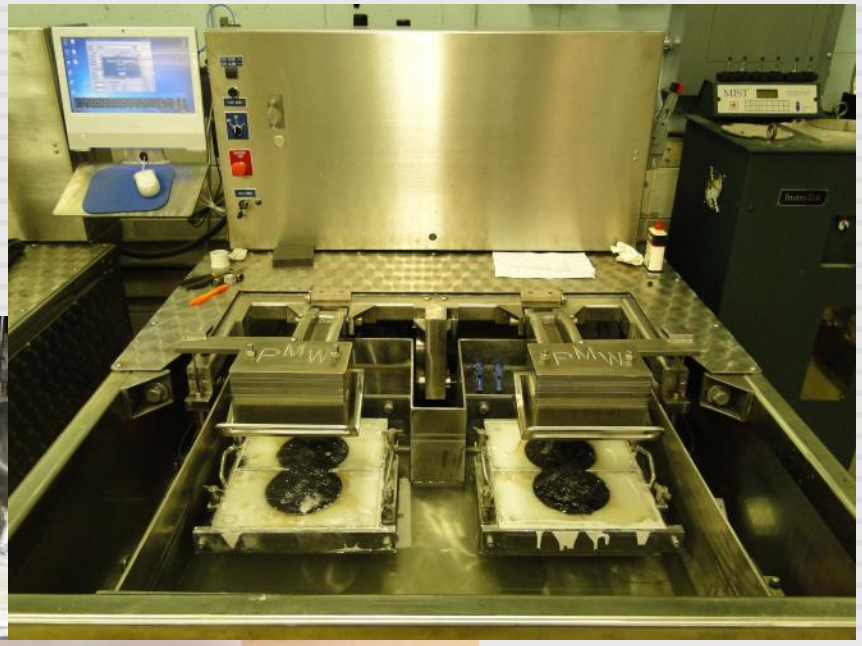
LADOTD Test Selection Criteria

- Mechanistic Tests
  - Pavement Performance
- Intermediate Temperature
  - Fatigue endurance
- High Temperature
  - Permanent deformation
- Features
  - Fundamental
  - Easy to Use
  - Reliable
  - Cost

Thermal Cracking	Fatigue Cracking	Permanent Deformation

Rutting Resistance: LWT Test

- Performance Indicator
  Resistance to Rutting and Moisture Sensitivity
- Test Protocol
  AASHTO T324
- Temperature
  50°C
- Loading



Wheel Diameter: 203.5 mm (8 inch)
Wheel Width: 47mm (1.85 inch)
Fixed Load: 703 N (158 lbs)
Rolling Speed: 1.1 km/hr
Passing Rate: 52 passes/min

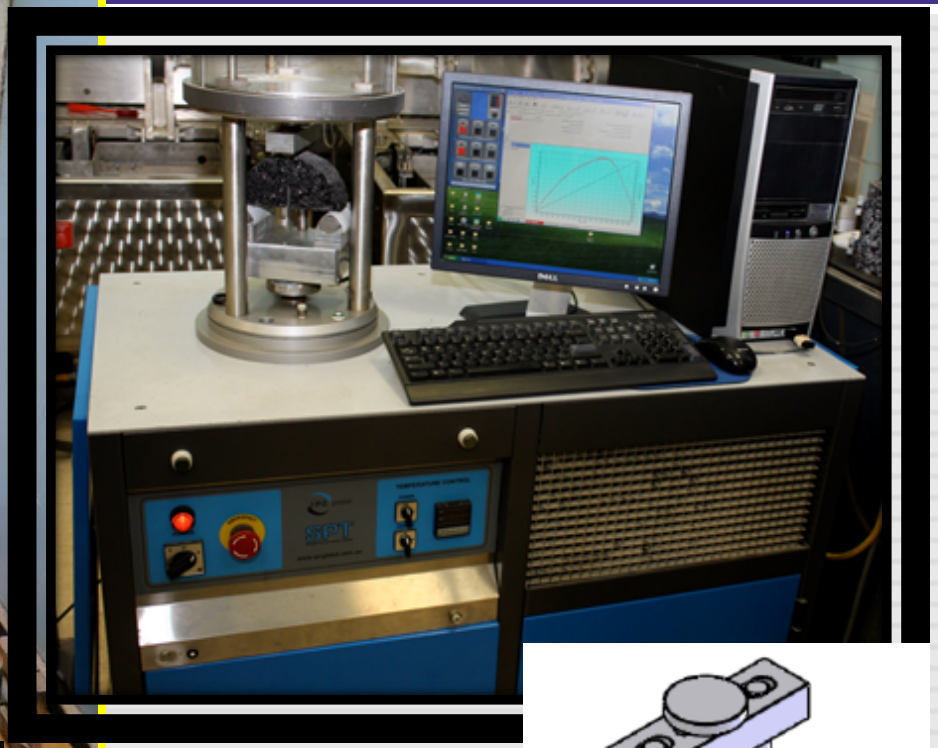
Cracking Test?

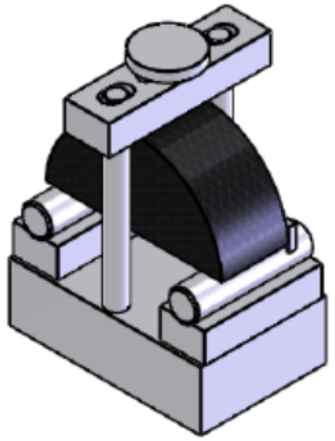
- Several options available
  - Bending Beam Fatigue, SVECD, Overlay Tester, Intermediate Temperature SCB, iFIT, Energy Ratio, Fracture Energy (ITS)
- Which one is "best"?
  - Each has advantages and disadvantages
- LADOTD selected Intermediate Temperature SCB
  - LADOTD TR 330
  - ASTM 8044

Why SCB?

- Intermediate Temperature test for Intermediate Temperature Fracture
- Gyratory and field core
- Simplicity of testing equipment
  - can be adapted to plant lab
- History of forensic success and field correlation
- Fundamental derived from fracture mechanics principles
  - Not an index based
- Test procedure
- Repeatable
  - Reporting COV of fracture energy less than 15%

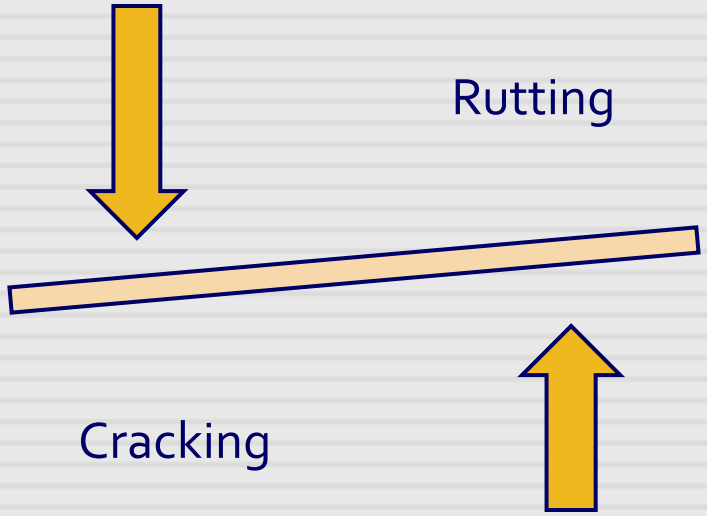
Test Equipment -- Development



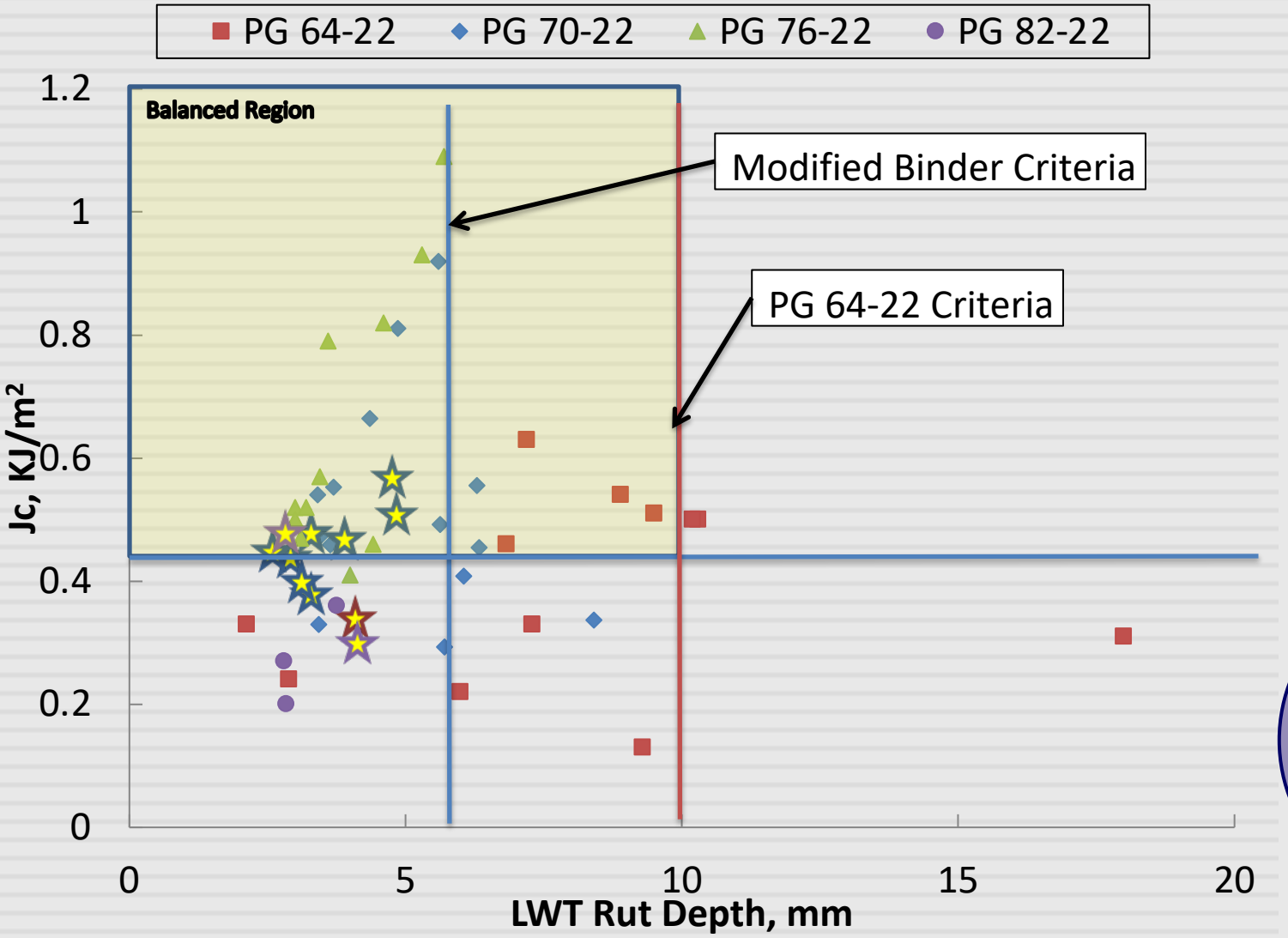


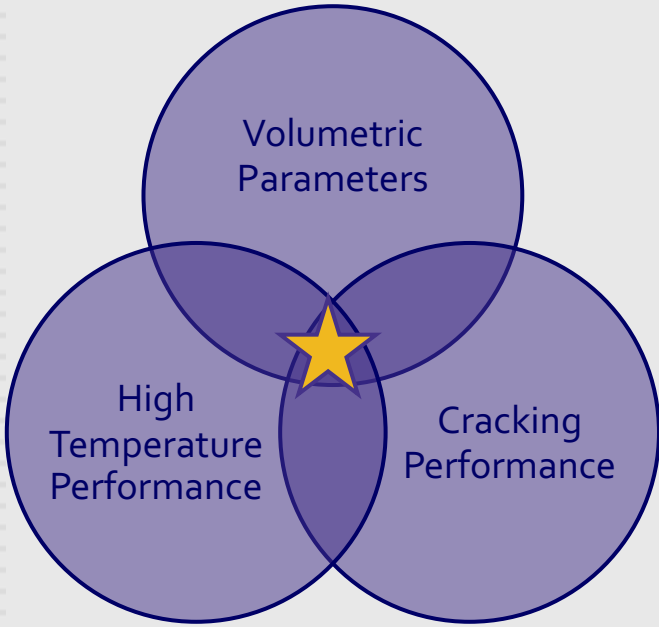
LADOTD Specification Changes

- Lowered Gyrations (Level 1 and Level 2)
  - L1: 55 Gyrations N_d
  - L2: 65 Gyrations N_d
- VTM Remains
  - 3.5%
- Raised design VFA
  - 72%
- Raised VMA
  - 0.5% Increase for each NMAS

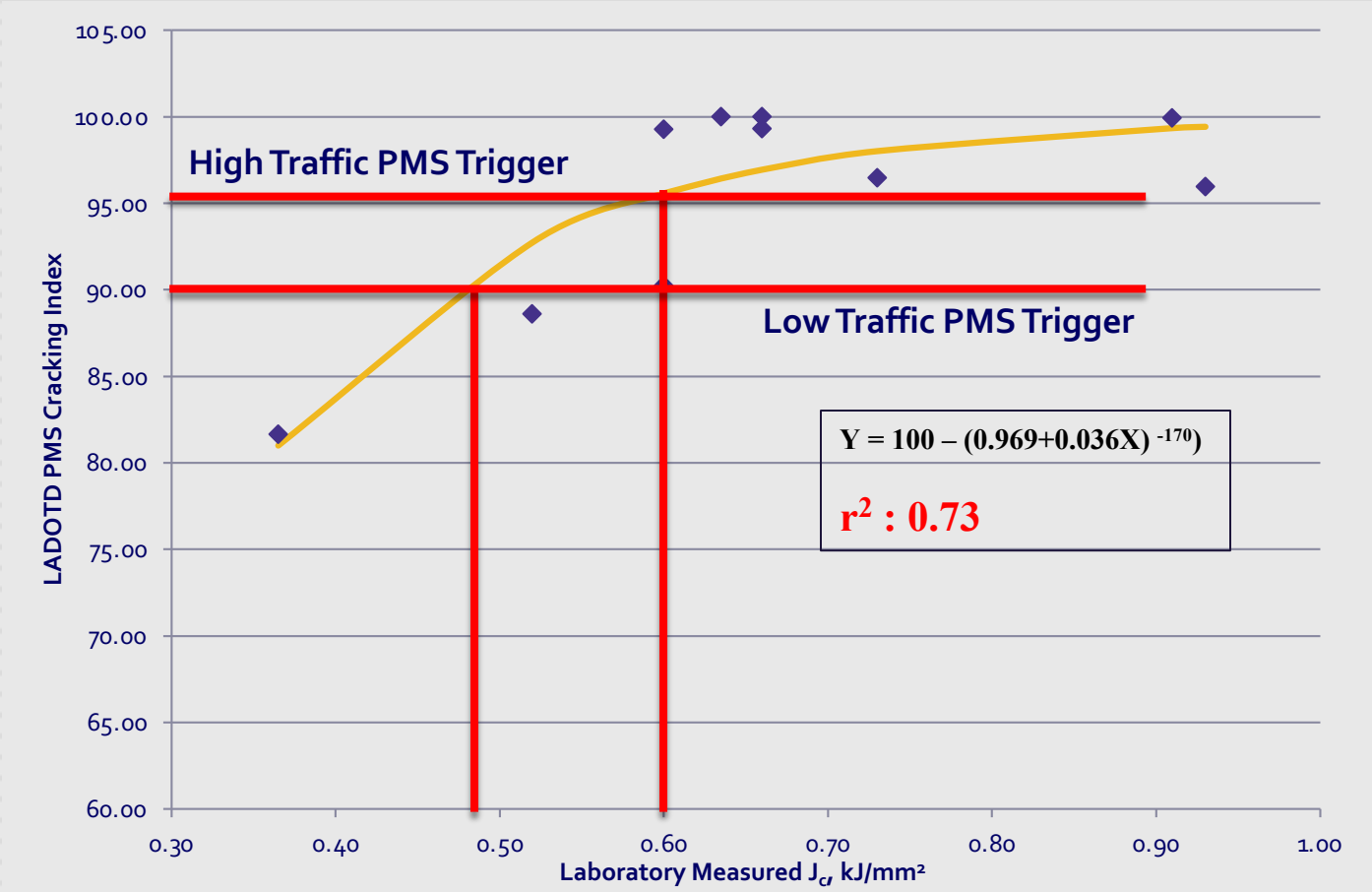


Analysis: Balanced Design





Field Validation: LTRC Project 10-4B



Field Validation: LTRC Project 10-4B

Table 502-7[1]
Asphalt Concrete General Criteria

Nominal Max., Size Agg.	0.5 inch (12.5 mm)			0.75 inch (19 mm)			1.0 inch (25 mm)				1.5 inch (37.5 mm)	BMA
Type of Mix	Incidental Paving[2]	Wearing Course		Wearing Course	Binder Course		Binder Course		Base Course	ATB[4]	Base Course	Wearing
Level[4]	A	1	2	2	1	2	1	2	1	1	1	2
Coarse Agg. Angularity, % Crushed, (Double Faced) + No. 4 (4.75 mm)	55	75	95	95	75	95	75	95	75	75	75	98
Fine Agg. Angularity, Min. % - No. 8 (2.36 mm)	40	40	45	45	40	45	40	45	40	40	40	45
Flat and Elongated Particles, % Max. (5:1)	10											
Sand Equivalent, Min. % (Fine Agg.) - No. 4 (4.75 mm)	40	40	45	45	40	45	40	45	40	40	40	NA
Natural Sand - Max. %	NA	15		15			15			25	25	0
Asphalt Binder	Table 502-2, (3% minimum for Asphalt Treated base (ATB), 6% min for SMA)											
Friction Rating[4]	Table 502-3											
RAP, Max. % of Mix[4]	20	15	15	15	20	20	20	20	30	30	30	0
Compacted Mix Volumetrics[4]												
VMA, Min. %[3]	13.5	13.5	13.5	12.5	12.5	12.5	11.5	11.5	11.5	n/a	10.5	16.0
Air Voids, %[5]	(2.5-4.5); (no limit for ATB)											
VFA, %[5]	(69-80); no limit for ATB											
Note 500k max.[7] (Gyrations)	7	7	7	7	7	7	7	7	7	n/a	7	7

LWT, Rut Depth, 50°C, Wet	Level 1 : 10mm @ 20,000 passes maximum, Level 2 : 6mm @ 20,000 passes maximum.
SCB, min, J_c, kJ/m^2 @ 25^0 C, Aged	Level 1 : Jc = 0.5 minimum , Level 2 : Jc = 0.6 minimum.

LADOTD Experience – What did we do?

- Developed a system to conduct mechanical property test to determine the anticipated performance of asphalt mixtures
  - LWT and SCB were the most feasible for implementation by state and contractor.

- Incorporate tests into state specification compliance evaluation.

LADOTD Experience – Train the People!!

- Semi Circular Bend (SCB) Test Training Workshop
  - April 16, 2015
- Participants
  - Contractors
  - LADOTD
  - Consultants

Semi Circular Bend (SCB) Test
Training Workshop
Agenda
April 16, 2015

8:00 – 8:30 am	Welcome and Announcements	Harold "Skip" Paul
8:30 – 9:45 am	Changes in the New Specification	Chris Abadie
9:45 – 10:00 am	Break	
10:00 – 11:30 am	SCB Training	
	a. SCB – History/Concept	Louay Mohammad (20 min)
	b. SCB - Research/Specification Review	Bill King (10 min)
	c. SCB – Testing	Sam Cooper III (60 min)
	i. Video	
	ii. Sample Prep	
	iii. Reporting	
11:30 – 12:30 pm	Lunch	Provided by LAPA
12:30 – 2:45 pm	Lab Demonstration of Test	Sam Cooper III/Lab Personnel
2:45 – 3:00 pm	Break	
3:00 – 4:00 pm	Open forum/Discussions/Questions	Chris Abadie/Bill King

LADOTD Experience – Make it practical

- Develop a plant lab SCB test protocol.
  - Utilize Marshall Load Frames.

- Contractors in the state have adopted the methodology and are currently evaluating mixtures with success.
  - Reporting low variability of fracture energy
    - <15%
  - Specimen fabrication is a complication
  - Long Term aging protocol – 5 day @ 85°C is a concern.

LADOTD Experience – Influence on Mixtures

- Districts have implemented the 2016 Specification
- LTRC is evaluating "balanced" mixtures designed under the new specifications
  - Increase in Hamburg Rut depth, still meets specification
  - SCB parameter, Jc, is being met
  - Asphalt Cement Increase of **~0.3 %**
  - VFA no longer on the bottom of the range
  - Pilot mixtures performing to date

LADOTD Experience – Observations

- Learning a lot about the relationship between base binders and mixture design.
  - Screens out binder blend compatibility concerns with latex and crumb rubber modification
  - **Binder Quality Matters!**

LADOTD Experience – Observations

- A few failures at the beginning of the implementation.
  - Contractors were made aware of the upcoming changes during the pilot period.
    - They were able to get their labs and mixtures ready during this time period.

LADOTD Experience – Innovation

Location	Mix Level	Asphalt Grade Required	Substitutions Allowed	
			Lower Grade[1]	Higher Grade
Mainline Wearing & Binder[2]	1	PG 70-22m	PG 67-22 (Binder only), with traffic volume < 3500 ADT	PG 82-22rm, and PG 76-22m
Mainline Wearing & Binder [3]	2 and SMA	PG 76-22m	~~PG 70-22m with~~ Hydrated Lime / ~~PG 70-22m~~ (Binder Only)	PG 82-22rm
Base[4]	1	PG 67-22	PG58-28[4]	PG 82-22rm, PG76-22m, PG70-22m
Minor Mixes, including Leveling[5]	ALL	PG 67-22		PG 82-22rm, PG76-22m, PG70-22m

[1]Lower grade substitutions are only allowed if LWT rut depths < 6mm for the design level.

[2] Semicircular bend test (SCB), minimum, Jc=0.5 KJ/m^2 required for all substitutions

[3]Semicircular bend test (SCB), minimum, Jc=0.6 KJ/m^2 required for all mainline substitutions

[4]When 21-30% Rap is used, PG58-28 is required

[5]For single lift overlay match grade of overlay

LADOTD Experience – Observations

- May still be too early to realize the full impacts of implementing BMD.
  - Current research ongoing to monitor roadways produced with the BMD specification and quantify life-cycle costs.
  - No reported premature cracking or rutting failures to date.

What's Next?

- Continue collecting a database of mixture LWT and J_c results and compare to field performance.
- Conduct research regarding the implementation of SCB into QC
  - Evaluate changes in test parameters from different specimen types
    - Mix Design vs. Plant Produced vs. Field Core
  - Develop accelerated aging protocol

Specification

- Supplemental Specification Link:
  - http://wwwsp.dotd.la.gov/Inside_LaDOTD/Divisions/Engineering/Standard_Specifications/Pages/Standard%20Specifications.aspx
    - 2016 Supplemental Specification
      - Part V Asphalt Pavement – 08/18