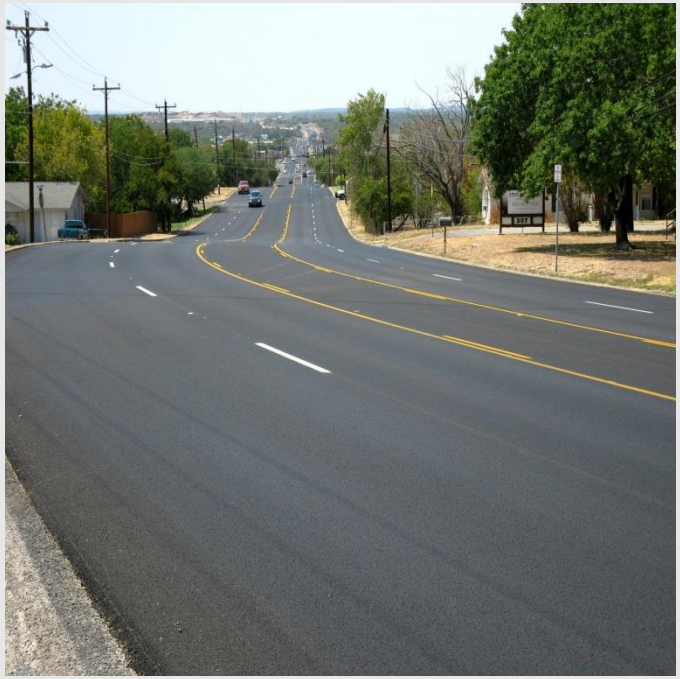
TEXAS DEPARTMENT OF TRANSPORTATION



TXDOT HIGH PERFORMANCE THIN OVERLAYS

Western Association of State Highways and Transportation Officials (WASHTO) – Materials and Construction Subcommittee
San Antonio, Texas
March 23, 2015

Table of Contents

Genesis of Thin Overlays

- Problem: Deficient performance life from conventional PM overlays
- Standard District Overlay Default: 2” D-GR TY C
  - Can’t afford premature failures and high long-term maintenance costs with limited future funding
- Re-examined our standard non-structural overlay practices for pavement preservation purposes

Genesis of Thin Overlays

- Dense Graded Overlay Issues:
  - Issues with raveling and failures due to segregation and low AC
  - Fatigue & Top Down Cracking
    - Due to premature aging and/or low AC
- HMA/Base Modulus Ratios > 10:1
  - Overly stiff mixtures due to recycled asphalt materials
  - Building in fatigue cracking to our pavement structures (16 to 20:1)

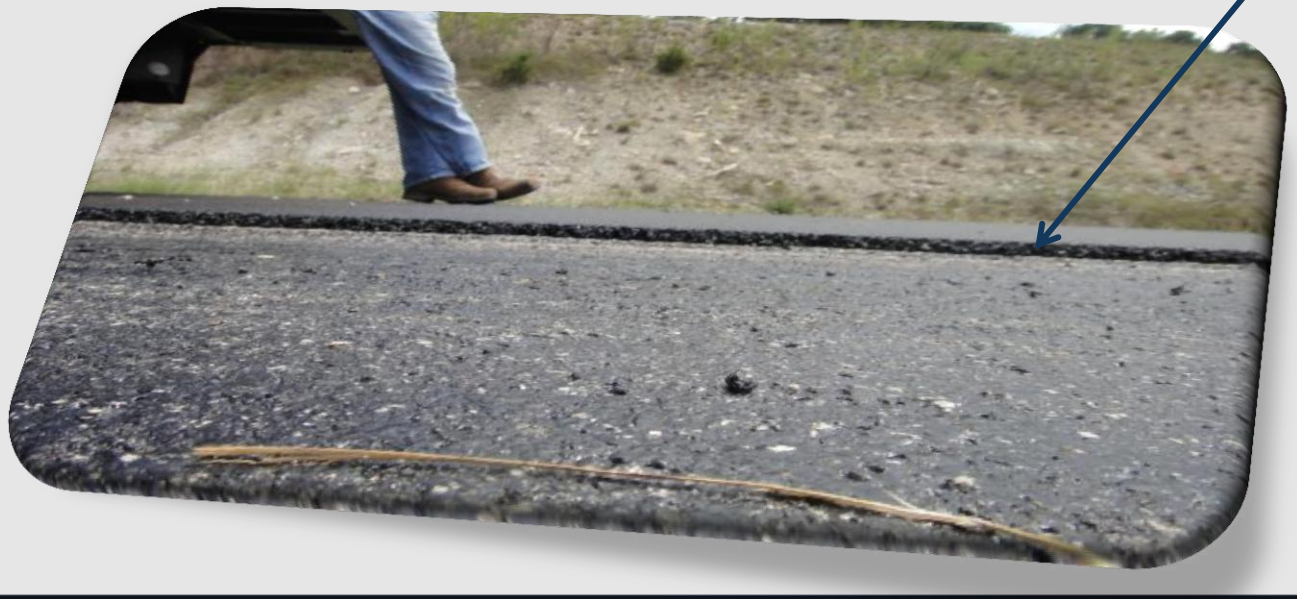
Genesis of Thin Overlays

- Goal: Develop a new strategy for PM overlays in the Austin District
  - Objective #1: Equal or better performance than current standard pavement preservation practices
    - Resist to rutting and cracking
    - Restore and improve ride
    - Restore and improve skid resistance
  - Objective #2: Less susceptible to premature distress
    - Less susceptible to segregation & premature aging
  - Objective #3: More cost-effective
    - Need to maximize every dollar
    - Cannot afford short service life

Genesis of Thin Overlays

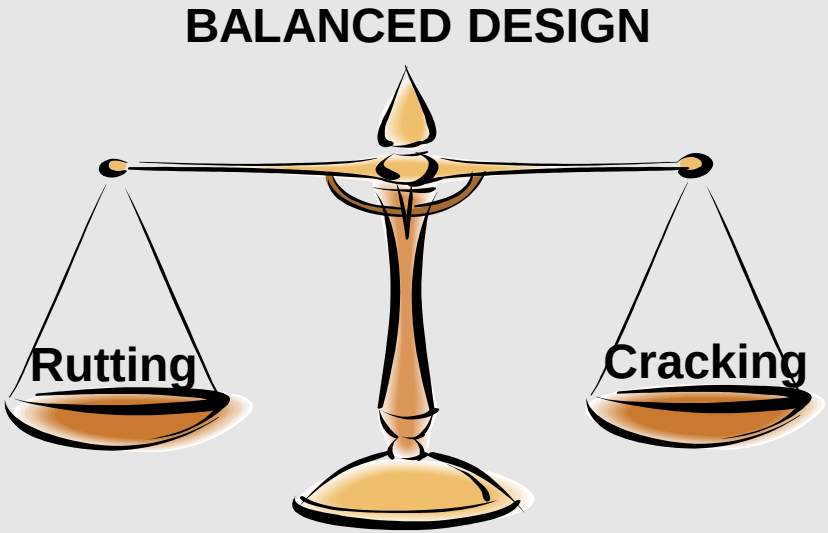
- Austin District Thin Overlay Pilot Program (2007):
  - Locally available high quality aggregate with finer gradations
  - 70% Grade 5 Sandstone
  - 30% Screenings
  - PG 76-22
  - 1” Thin Overlay Mixture

Not everything is bigger in Texas



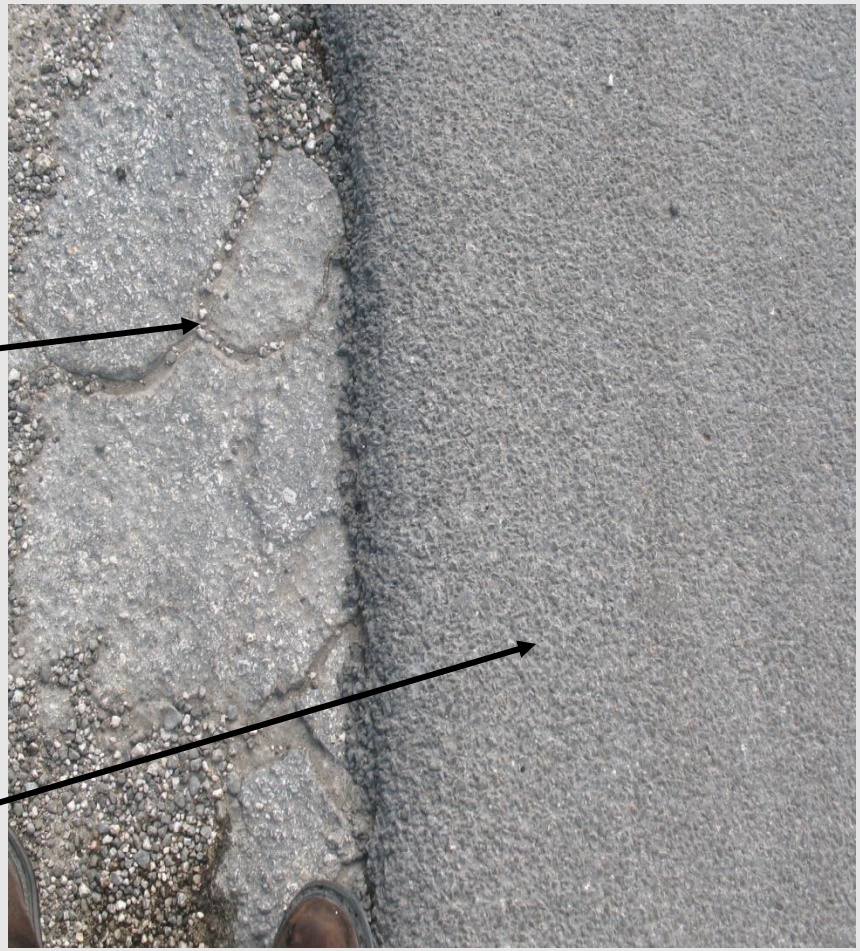
Genesis of Thin Overlays

- First Mix Design:
  - Density = 97.5%
  - AC = 6.7%
  - Hamburg = 20,000 passes @ 5.3 mm rut depth
  - Indirect Tensile = 123 psi.
  - Overlay Test = 453 cycles



Genesis of Thin Overlays – Test Section #1 (Ramming Plant)

- Pavement Condition
  - Severely fatigue and block cracked
  - Multiple failures
  - Crack widths ≤ 3/4”
- Construction: May 2007
  - No repair to failures or fatigue areas
  - Heavy emulsion tack coat
  - Overlay directly on existing pavement



Genesis of Thin Overlays

- Truck Loading (May 2007 to August 2011)
  - Practically 100% Heavy Trucks (Haul trucks & Transports)
  - >4.5 million total tonnage (material and trucks) shipped in and out since overlay
  - No distress to date

Genesis of Thin Overlays – Test Section #2 (IH35 Frontage Rd.)

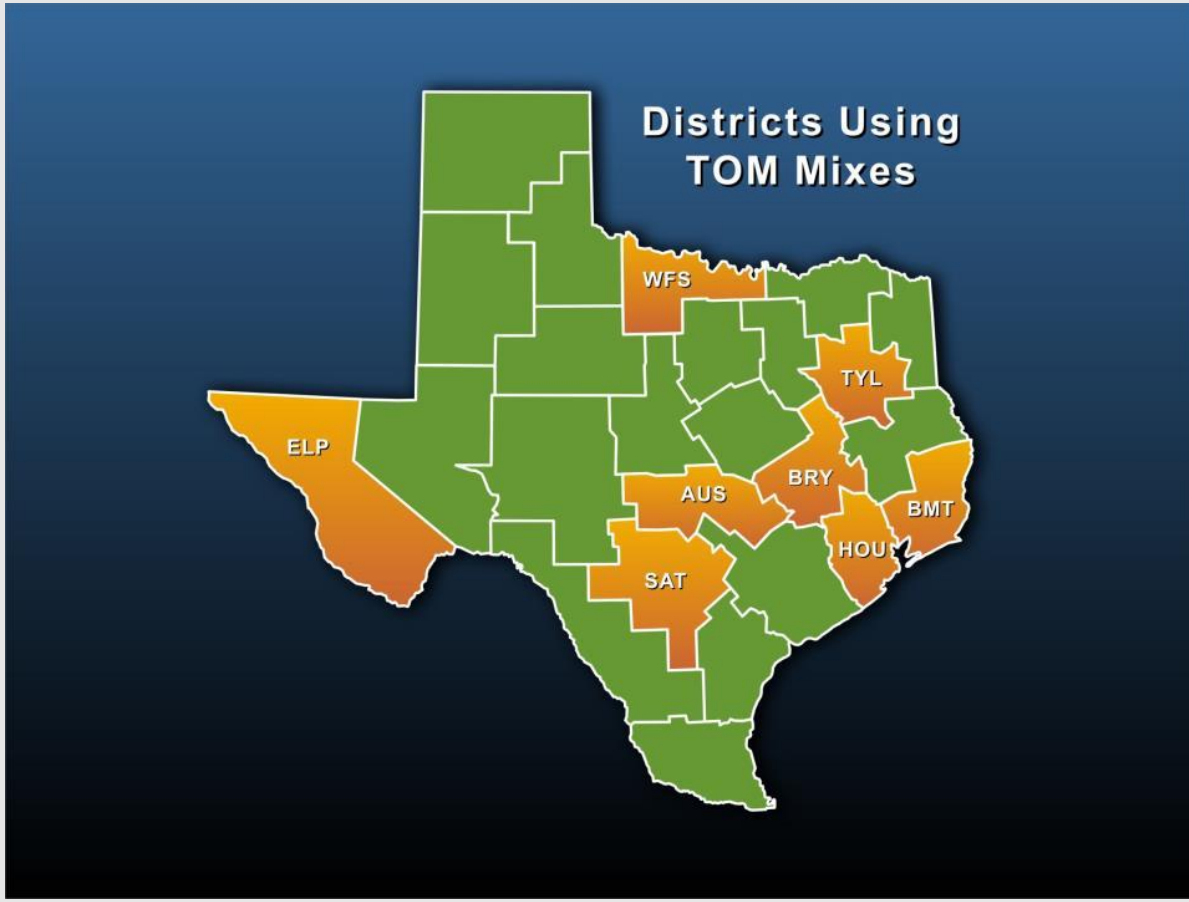
- ADT = 44,000
- High distressed
- Skid Number = mid 40's
- Improved Ride – 35% improvement
- Five years until first crack seal
- Added Bonus: Quiet Ride Properties
  - Avg.= 94-98 dBA
  - PFC ~ 98 dBA

Genesis of Thin Overlays

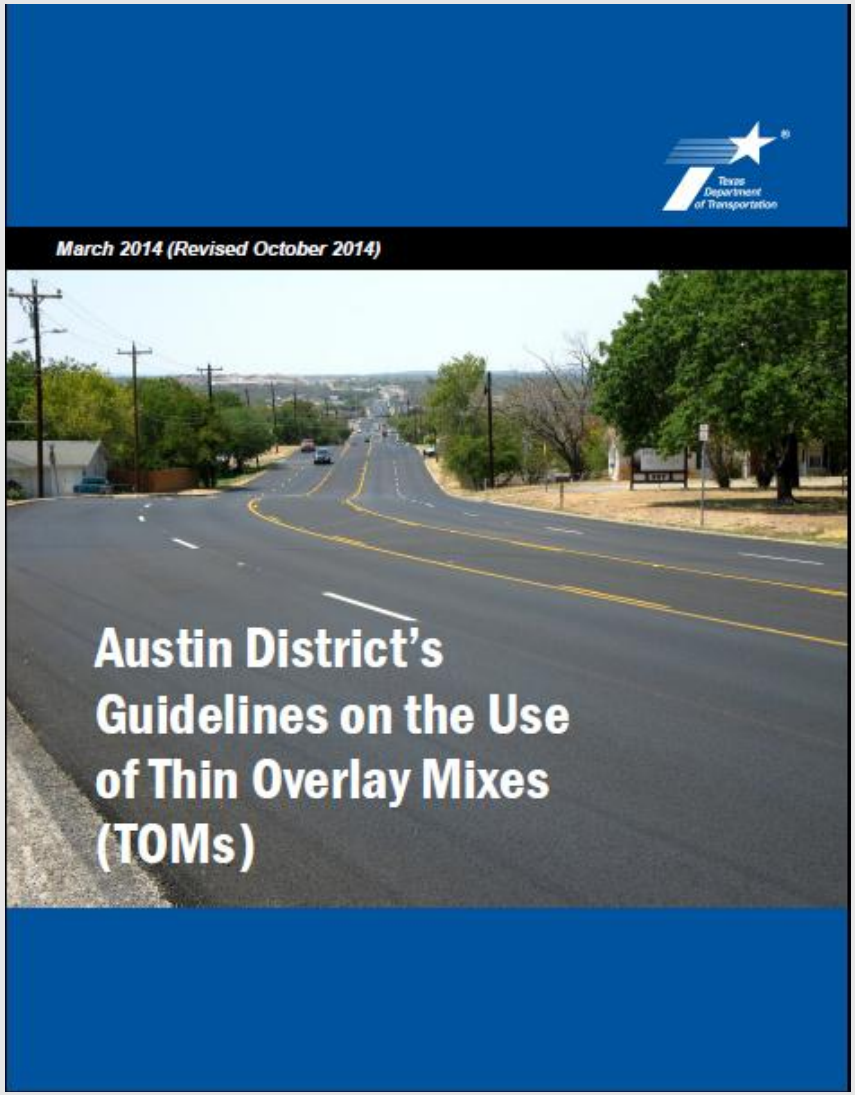
- Evaluated Thin Overlay Pilot Program:
  - Objective #1: Equal or better performance than current standard pavement preservation practices
    - Improved Ride Quality (25-35% Improvement)
    - High Skid Resistance (mid 40s to mid 50s)
    - Noise Reduction (~98 dBA)
  - Objective #2: Less susceptible to premature distress
    - High AC; High Quality Aggregate
    - Balance Design
  - Objective #3: More cost effective: YES!!!
    - TOMs = $5.50 per SY
    - TY C = $7.20 per SY
- Full Implementation in FY 2008

Genesis of Thin Overlays

- Austin District:
  - 77 TOM projects
  - 413,000 tons or 1066 lane miles
- 10 Other Districts:
  - 25 projects
  - 177,000 tons or 476 lane miles



Austin District Guidelines on the Use of TOMs



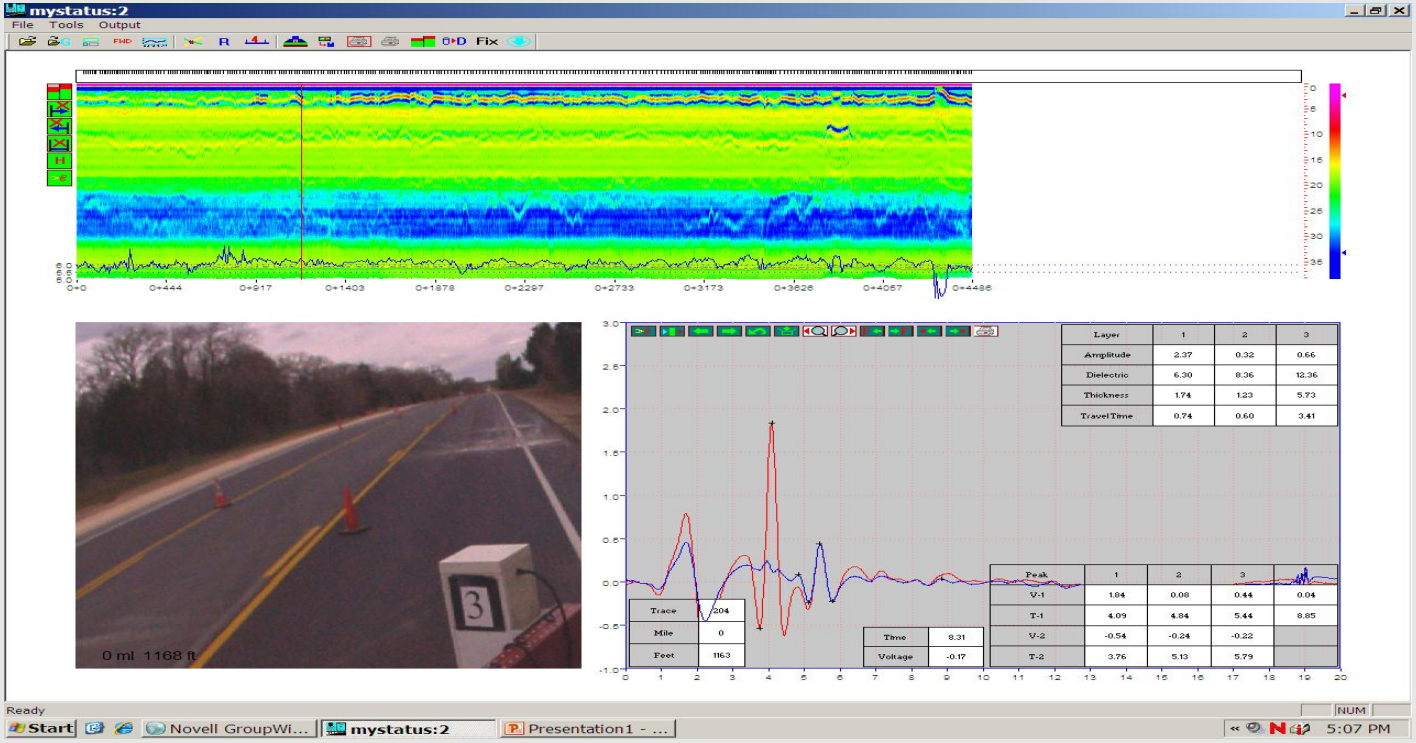
- Pavement Selection Considerations
- Mix Design & Material Properties
- Keys to Successful Construction

Pavement Selection Consideration for TOMs

- Where can I use Thin Overlay Mixtures (TOMs)?
- Answer: Thin overlays should used on pavements:
  - Structurally sound – Pavements needing extensive rehabilitation or requiring structural improvement should be avoided.
    - FPS 21 pavement design analysis predicts an overlay of 2” or less
  - Pavement Preservation – Only requiring restoration of the surface wearing course properties, such as skid resistance, elimination of surface distresses, improve ride quality, reduce noise.

Pavement Selection Consideration for TOMs

- Pavement Evaluation – Need to do your homework!
- Network Level Structural Evaluation
  - Ground Penetrating Radar (GPR): Determine existing pavement thickness, including HMA and base course thickness



Pavement Selection Consideration for TOMs

- Pavement Evaluation – Need to do your homework!
- Network Level Structural Evaluation
  - Falling Weight Deflectometer (FWD): Pavement response to determine overall pavement capacity and subgrade support

Pavement Selection Consideration for TOMs

- Structural Condition Index (SCI)
- SCI is the ratio of existing structural capacity and required structural capacity for 20 year ESAL

$$SCI = SN_{eff} / SN_{req}$$

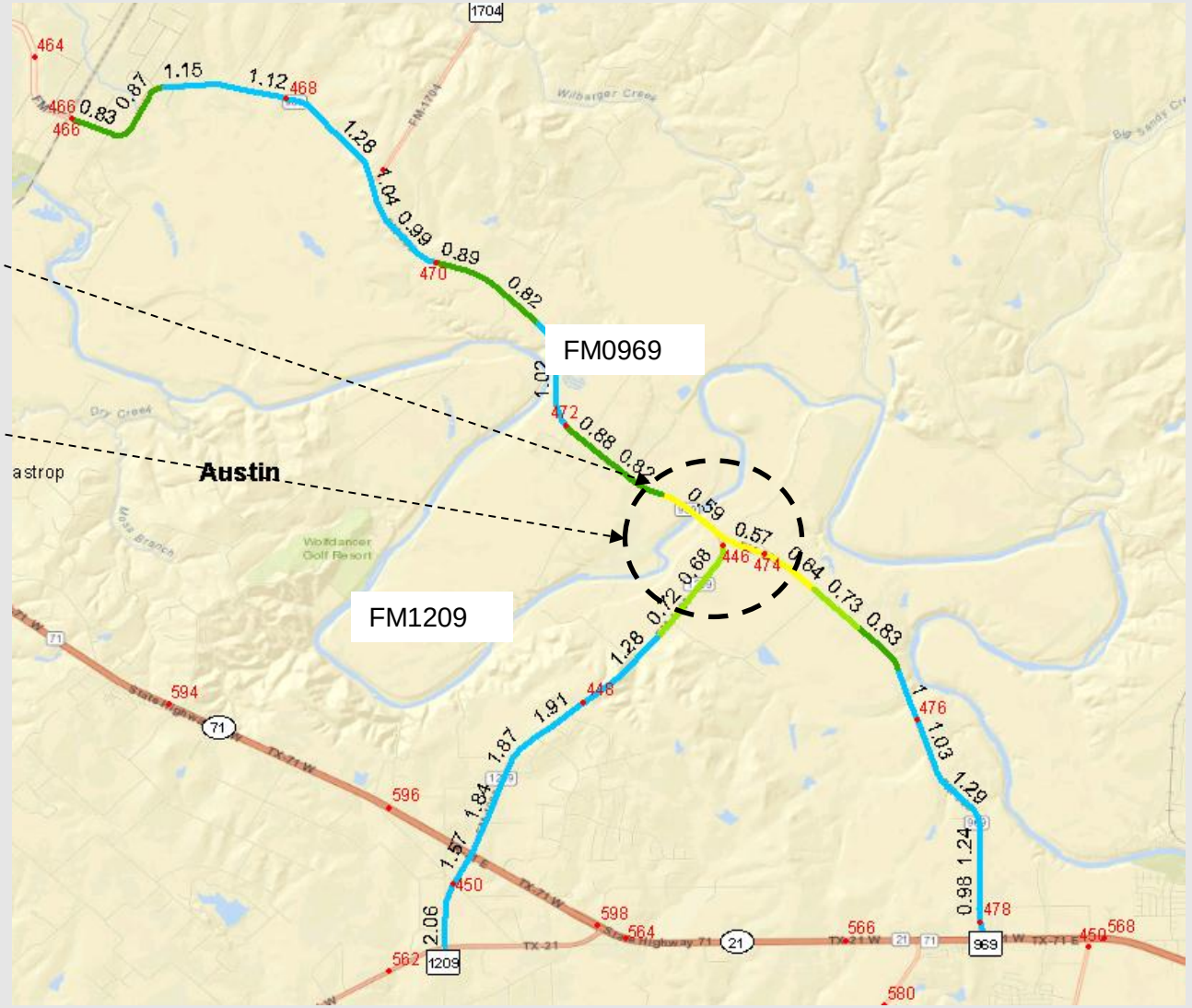
SN_{eff} = f(total thickness, FWD deflections)

SN_{req} = f(20-year ESALs, subgrade Mr)

SCI Scores (SCI*100)	M&R Category
90–100	Do Nothing
80–89	PM
65–79	LRhb
50–64	MRhb
0–49	HRhb

- Thin Overlay option for SCI > 70
- Spot repair and Level-up for SCI = 70 – 80

Pavement Selection Consideration for TOMs

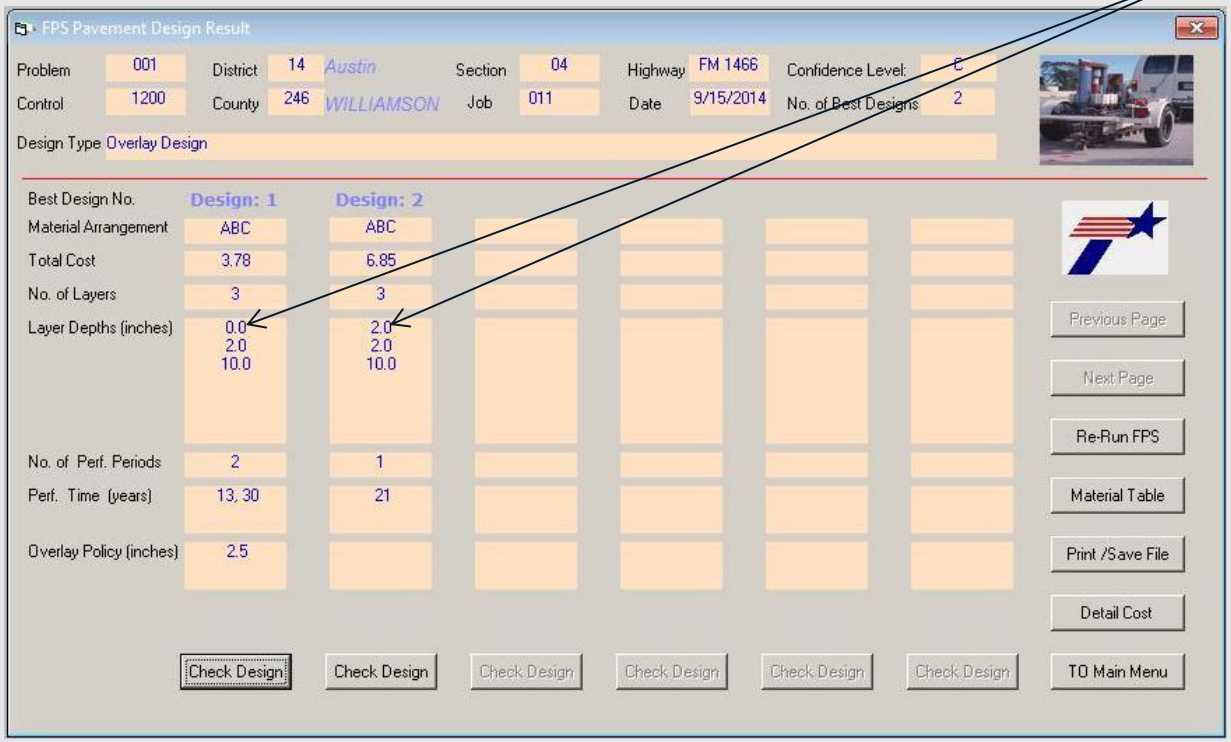


Average_SCI_Score
- Need MRhb
- Need LRhb
- Need PM
- Do Nothing

Pavement Selection Consideration for TOMs

- Pavement Overlay Design Process
  - Perform Overlay Design in FPS 21
  - Use pavement section from GPR data
  - Use subgrade support data from FWD data

TOMs okay if FPS 21 pavement design analysis predicts an overlay of 2" or less



Mix Design & Material Properties

- Material Properties
  - High Quality Aggregates
  - Polymer Modified Asphalt
    - PG 70-22 or 76-22
    - Typical Target AC TOM-C = 6.2 – 6.8%
    - Typical Target AC TOM-F = 6.8 – 7.4%
  - No Recycled Asphalt = No RAP or RAS

Mix Design & Material Properties

Aggregate Quality Requirements

Property	Test Method	Requirement
Coarse Aggregate		
SAC	Tex-499-A (AQMP)	A[1]
Deleterious material, %, Max	Tex-217-F, Part I	1.5
Decantation, %, Max	Tex-217-F, Part II	1.5
Micro-Deval abrasion, %	Tex-461-A	Note[2]
Los Angeles abrasion, %, Max	Tex-410-A	30
Magnesium sulfate soundness, 5 cycles, %, Max	Tex-411-A	20
Crushed face count[3], %, Min	Tex 460-A, Part I	95
Flat and elongated particles @ 5:1, %, Max	Tex-280-F	10
Fine Aggregate		
Linear shrinkage, %, Max	Tex-107-E	3
Combined Aggregate[4]		
Sand equivalent, %, Min	Tex-203-F	45

1. Surface aggregate classification of “A” is required unless otherwise shown on plans.
2. Used to estimate the magnesium sulfate soundness loss in accordance with Section 347.2.1.1.2., “Micro-Deval Abrasion.”
3. Only applies to crushed gravel.
4. Aggregates, without mineral filler, or additives, combined as used in the job-mix formula (JMF).

Mix Design & Material Properties

Master Gradation Limits (% Passing by Weight or Volume) and Volumetric Requirements

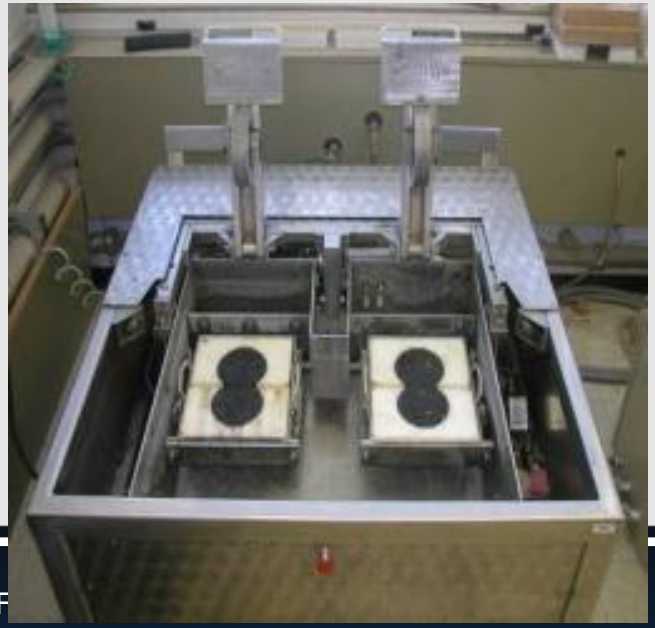
Sieve Size	Coarse (TOM – C)	Fine (TOM-F)
1/2 in.	100.0[1]	100.0[1]
3/8 in.	95.0 – 100.0	98.0 – 100.0
#4	40.0 – 60.0	70.0 – 95.0
#8	17.0 – 27.0	40.0 – 65.0
#16	5.0 – 27.0	20.0 – 45.0
#30	5.0 – 27.0	10.0 – 35.0
#50	5.0 – 27.0	10.0 – 20.0
#200	5.0 – 9.0	2.0 – 12.0
Asphalt Binder Content[2], % Min		
-	6.0	6.5
Design VMA[3], % Min		
-	16.0	16.5
Production (Plant-Produced) VMA[3], % Min		
-	15.5	16.0

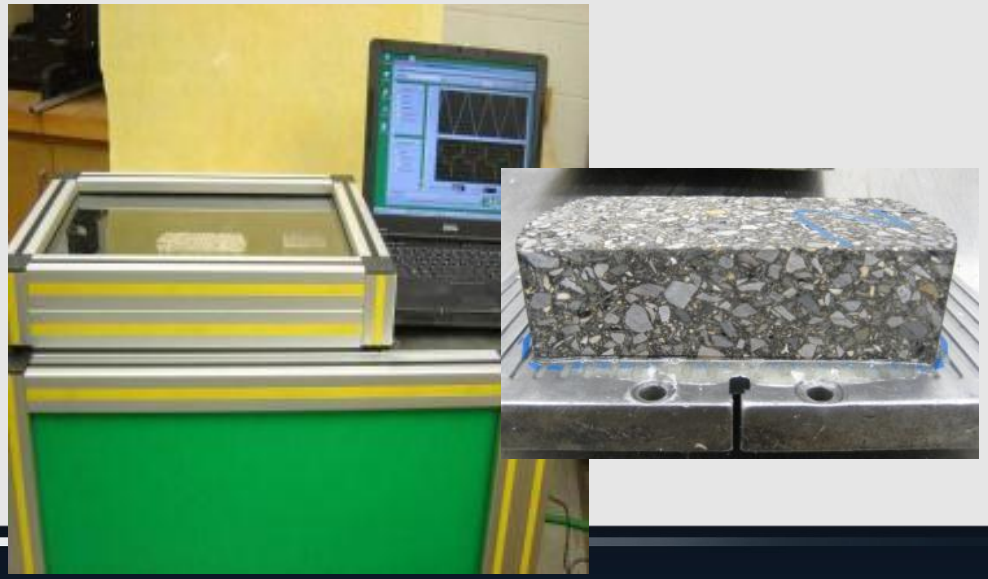
1. Defined as maximum sieve size. No tolerance allowed.
2. Unless otherwise shown on the plans or approved by the Engineer.
3. Voids in Mineral Aggregates (VMA).

Mix Design & Material Properties

Laboratory Mixture Design Properties

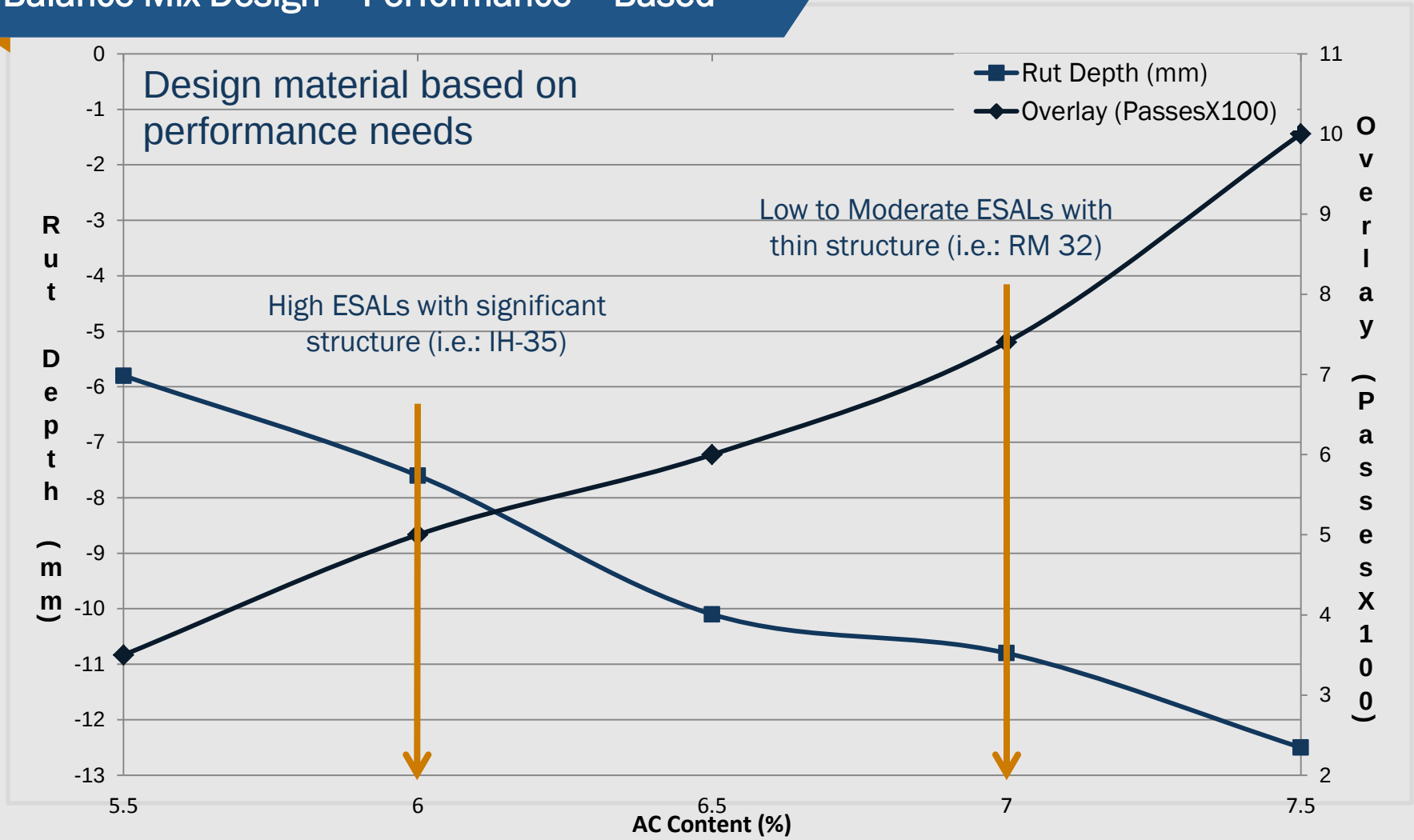
Mixture Property	Test Method	Requirement
Target laboratory-molded density, % (TGC)	Tex 207 F	97.5[1]
Design gyrations (Ndesign for SGC)	Tex-241-F	50[2]
Hamburg Wheel test, passes at 12.5 mm rut depth for PG 70 mixtures	Tex-242-F	15,000 Min
Hamburg Wheel test, passes at 12.5 mm rut depth for PG 76 mixtures	Tex-242-F	20,000 Min
Tensile strength (dry), psi.	Tex-226-F	85-200
Overlay test, number of cycles	Tex-248-F	300 Min
Drain-down, %	Tex-235-F	0.20 Max





Mix Design & Material Properties

Balance Mix Design – Performance – Based

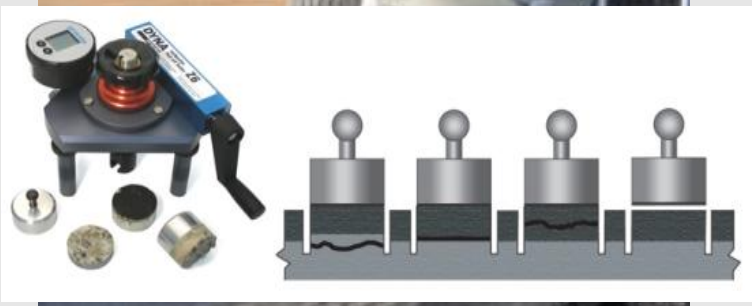


Keys to Successful Construction

- Preparation
  - Spot Repair: Isolated failures
  - Level-Up: Areas with greater than 120 in/mile
  - Milling: Recommend micromilling for smaller peak to valley

Keys to Successful Construction

- BONDING IS CRITICAL
- Bonding/Sealing Courses
  - Non-tracking Tack Coats
  - Spray Paver Underseal Membranes
  - Seal Coat Underseals
  - New Non-tracking Hot-Applied Asphalt
- Performance-based bonding course specification



Keys to Successful Construction

- Placement – Temperature
  - 1” Thin overlay cools twice the rate of a 1.5” mat

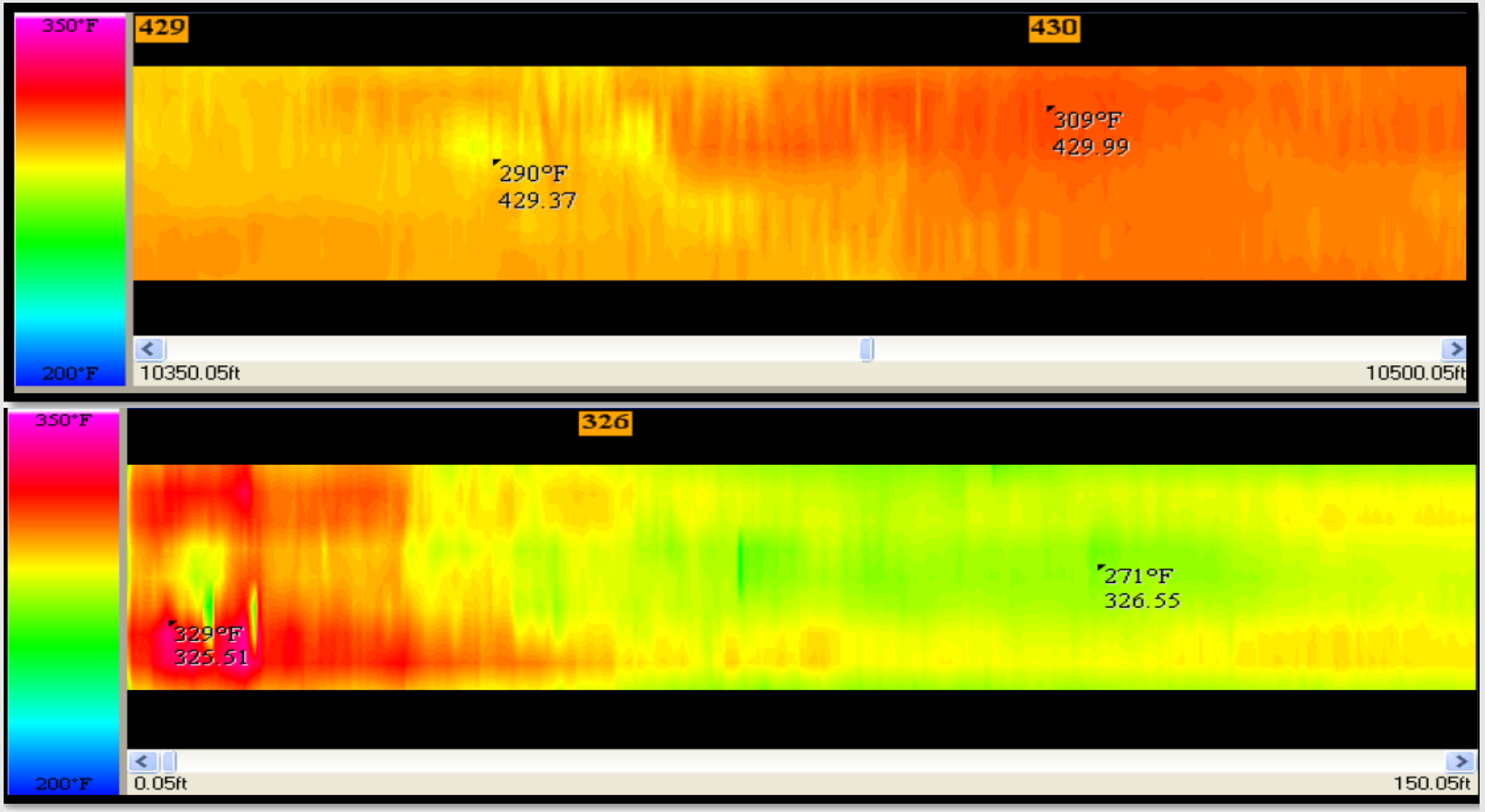


Figure 5. Severe Thermal Segregation in First Profile from CMHB-F.

Keys to Successful Construction

- Placement Best Practices
  - Use a shuttle buggy to maintain temperature
  - Use insulated truck and trapped
  - Place when ambient temp. 70° F or greater
    - WMA required 60 –70° F ambient temp. but produce greater than 300° F. Compaction aid.
    - WMA additive also required for haul distances ≥ 40 miles.
  - IR-bar highly recommended
  - Tandem dual rollers close to the paver
  - No pneumatics

Keys to Successful Construction

- Acceptance Testing
  - Too thin to measure in-place air voids accurately
  - Require TxDOT water flow test (Tex-246-F) to ensure adequate density and impermeability.
    - Water flow should be greater than 120 seconds.
  - Thermal segregation profile or use of the Pave-IR is critical to identify segregation which may lead to low density, permeability, and water infiltration

Long-Term Performance - TOMs

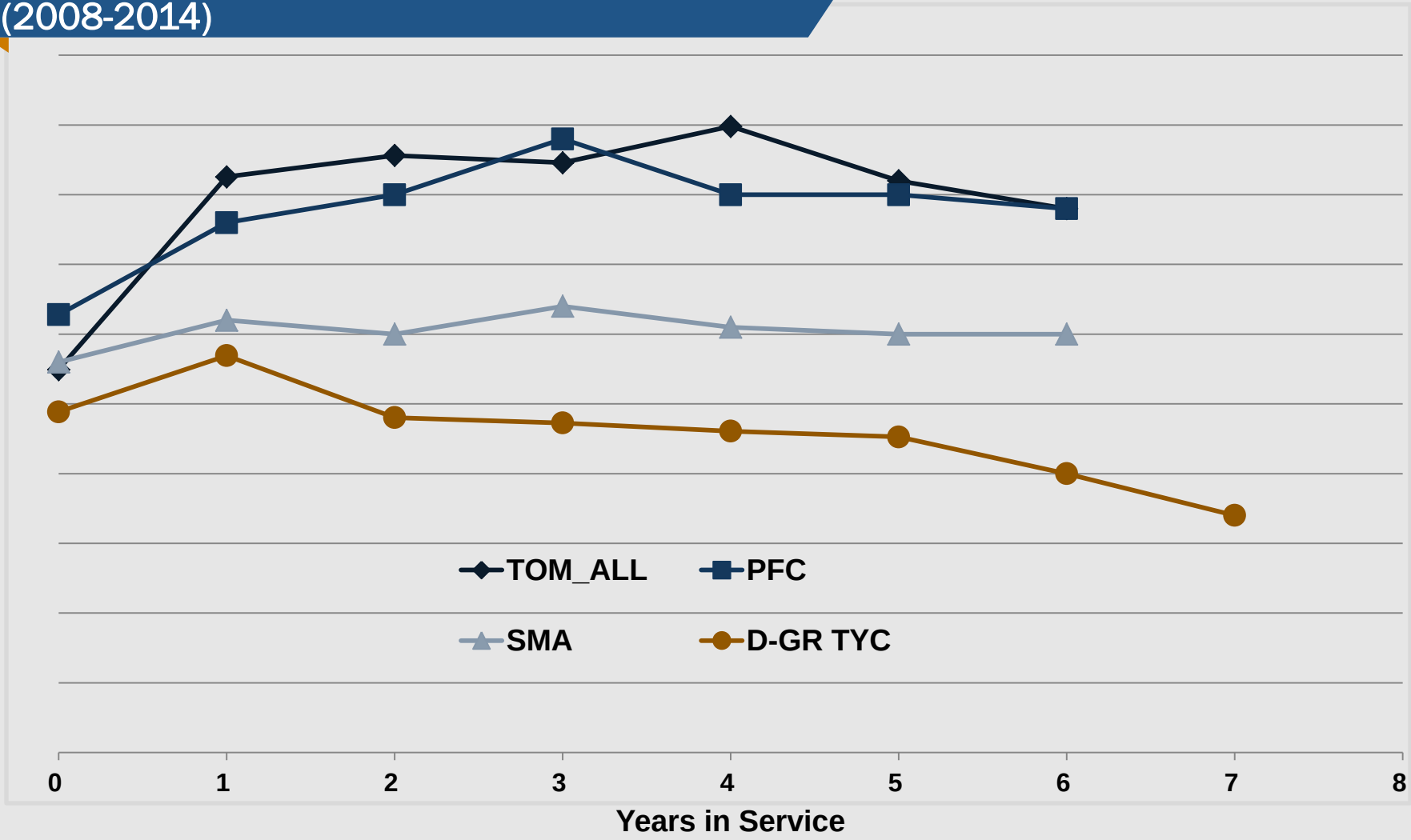
- "How are they performing?"
- Objectives from PM Overlays
  - Safety: Restore surface friction and resistance to skid in wet weather
  - Durability: Eliminate and prevent long-term surface distress (rutting/cracking)
  - User Satisfaction – improve ride quality and noise reduction
  - Longevity: Service life of 8 – 10 years with the least amount of routine maintenance as possible (crack seal, patching, strip seals, etc…)

Long-Term Performance - TOMs

- Long-term Skid Resistance Performance
  - Open-graded surface = Good Macro-texture = Good Skid Resistance

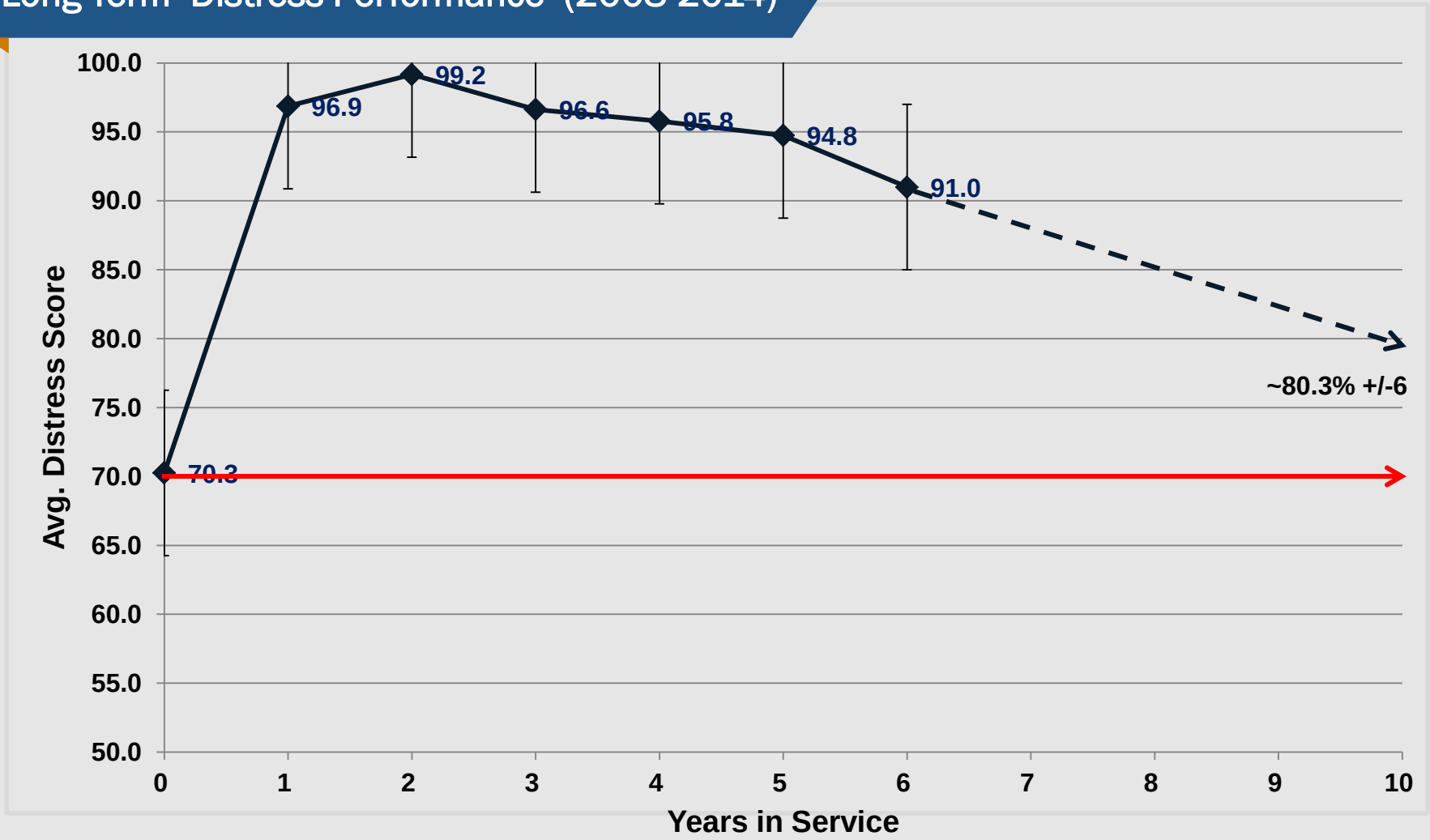
Long-Term Performance - TOMs

Long-Term Skid Resistance Performance (2008-2014)



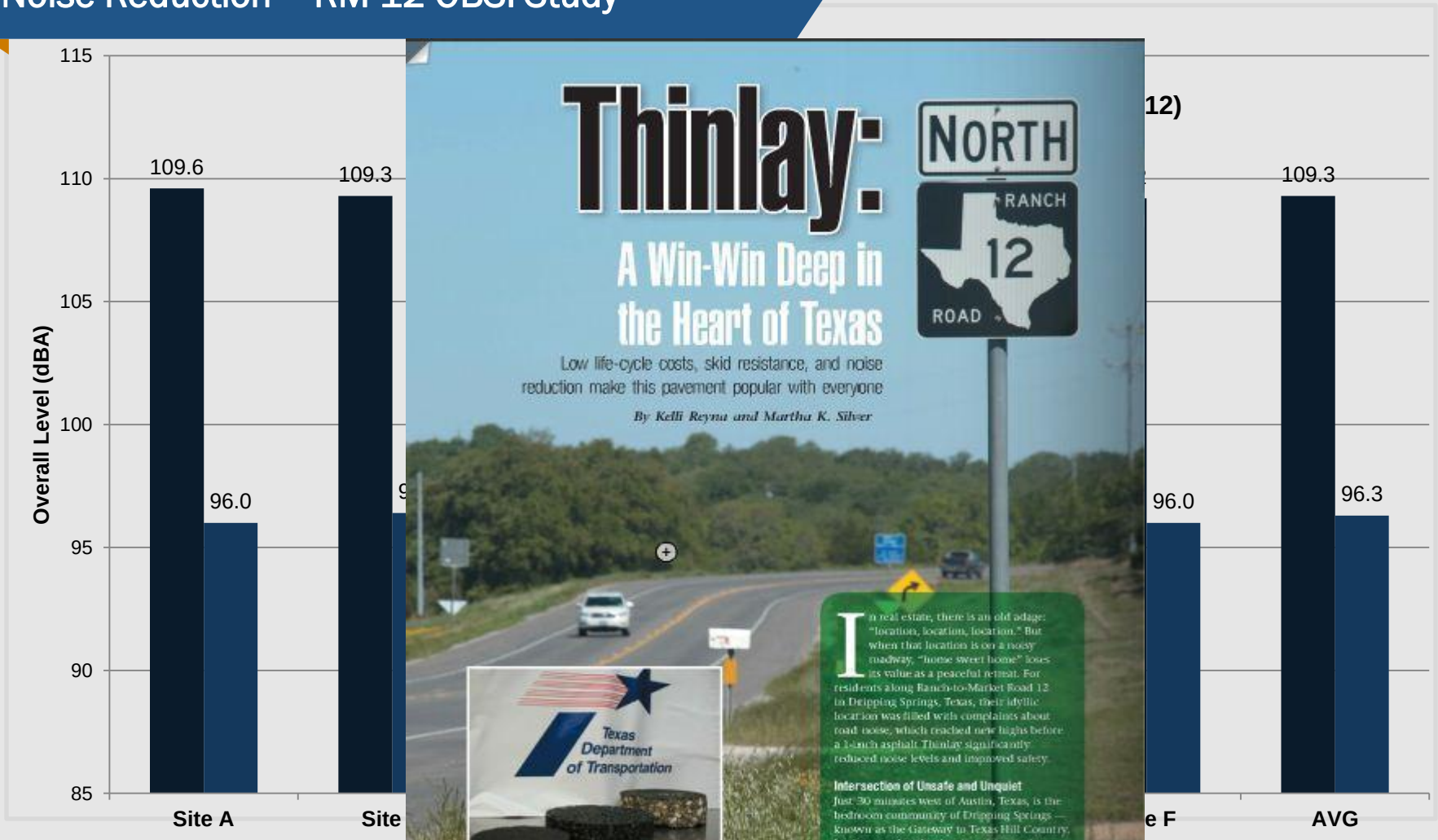
Long-Term Performance - TOMs

Long-Term Distress Performance (2008-2014)



Long-Term Performance - TOMs

Noise Reduction – RM 12 OBSI Study



Long-Term Performance - TOMs

- Objectives from PM Overlays:
  - Safety: High, sustainable surface friction over time
  - Durability: Distress scores over 90% over the last six years on average
  - User Satisfaction –
    - IRI improvement of at least 25% and up to 40% from pre-existing IRI
    - Well documented noise reduction

Long-Term Performance - TOMs

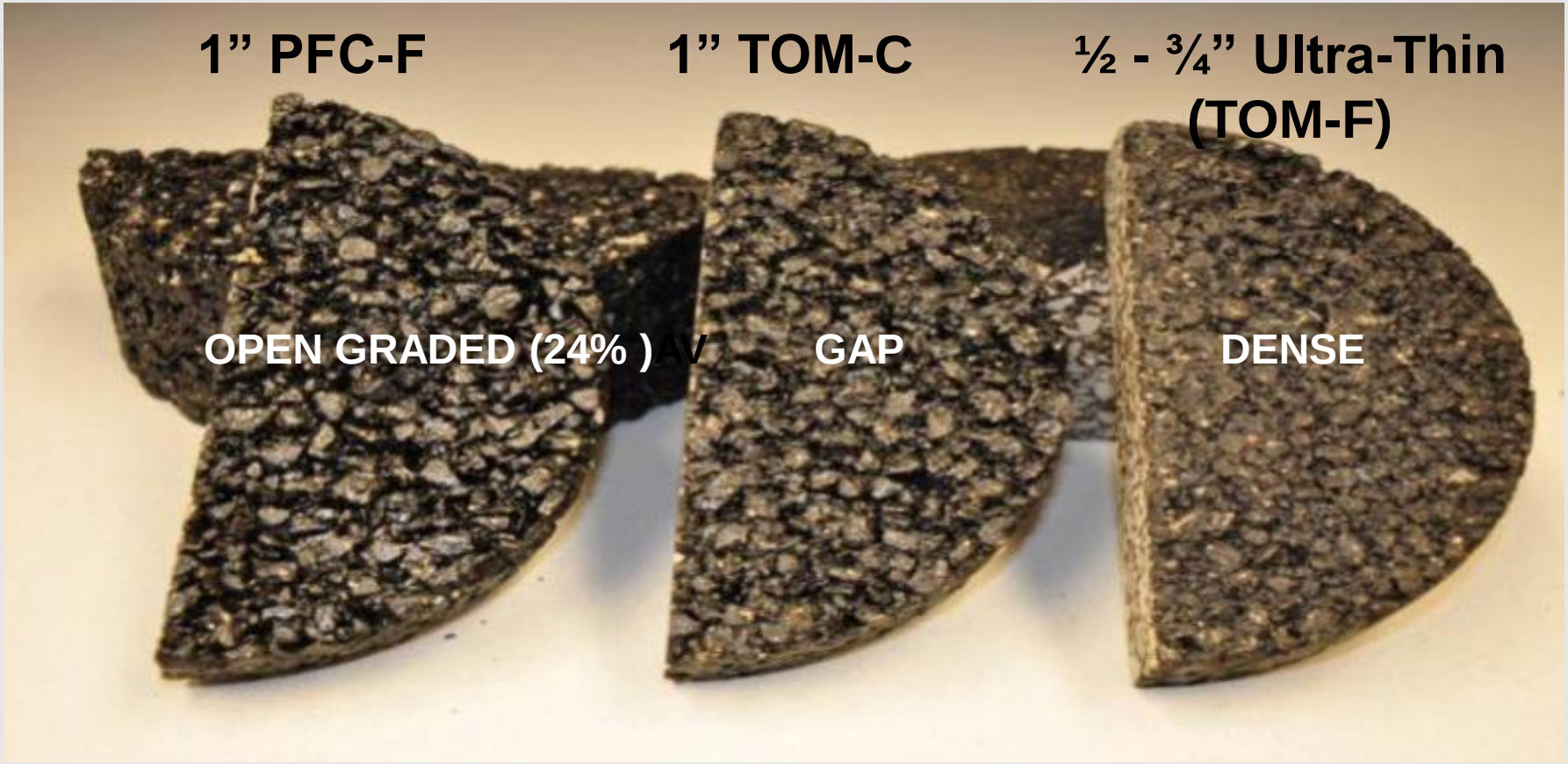
- Objectives from PM Overlays
  - Longevity: On average, a service life of 8 – 10 years could be projected with minimal routine maintenance
  - Initial Cost (12 month avg. low bid unit price):
    - 1” TOM = $6.80/SY
    - 1.5” D-GR TY D = $6.74/SY
    - 2” D-GR TY C = $7.92/SY
  - Austin District Cost Savings ~ $17 million
  - Statewide Annual Cost Savings ~ $9 million
  - Life Cycle Cost Analysis (LCCA) – On-Going Analysis
    - Time to first crack seal for D-GR HMA with Recycled Asphalt = ~18-24 months
    - Time to first routine maintenance for TOM = ~4-5 years

Long-Term Performance - TOMs

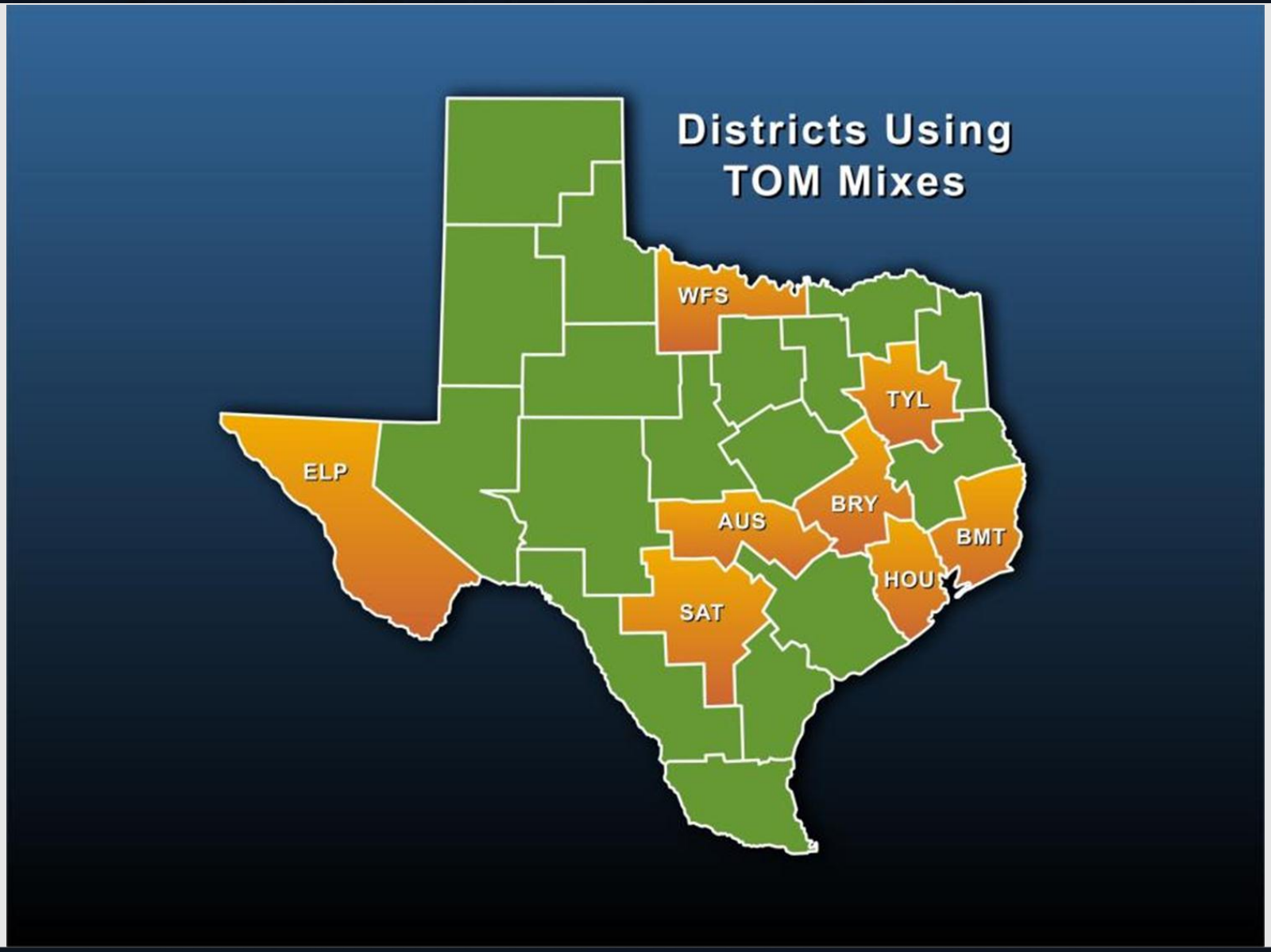
- Issues
- High rate of oxidations of modified asphalts
  - REOBs/PPA
  - Over-stiffening leading to premature cracking and raveling
- Aggregate supply
  - Industry recalibrating crushing fractions
- Debonding issues
  - Non-tracking tack coats picking up during construction
  - Not allowing to set or spilling hot mix on the tack coat
- Use in wrong applications

New Mixtures & Applications

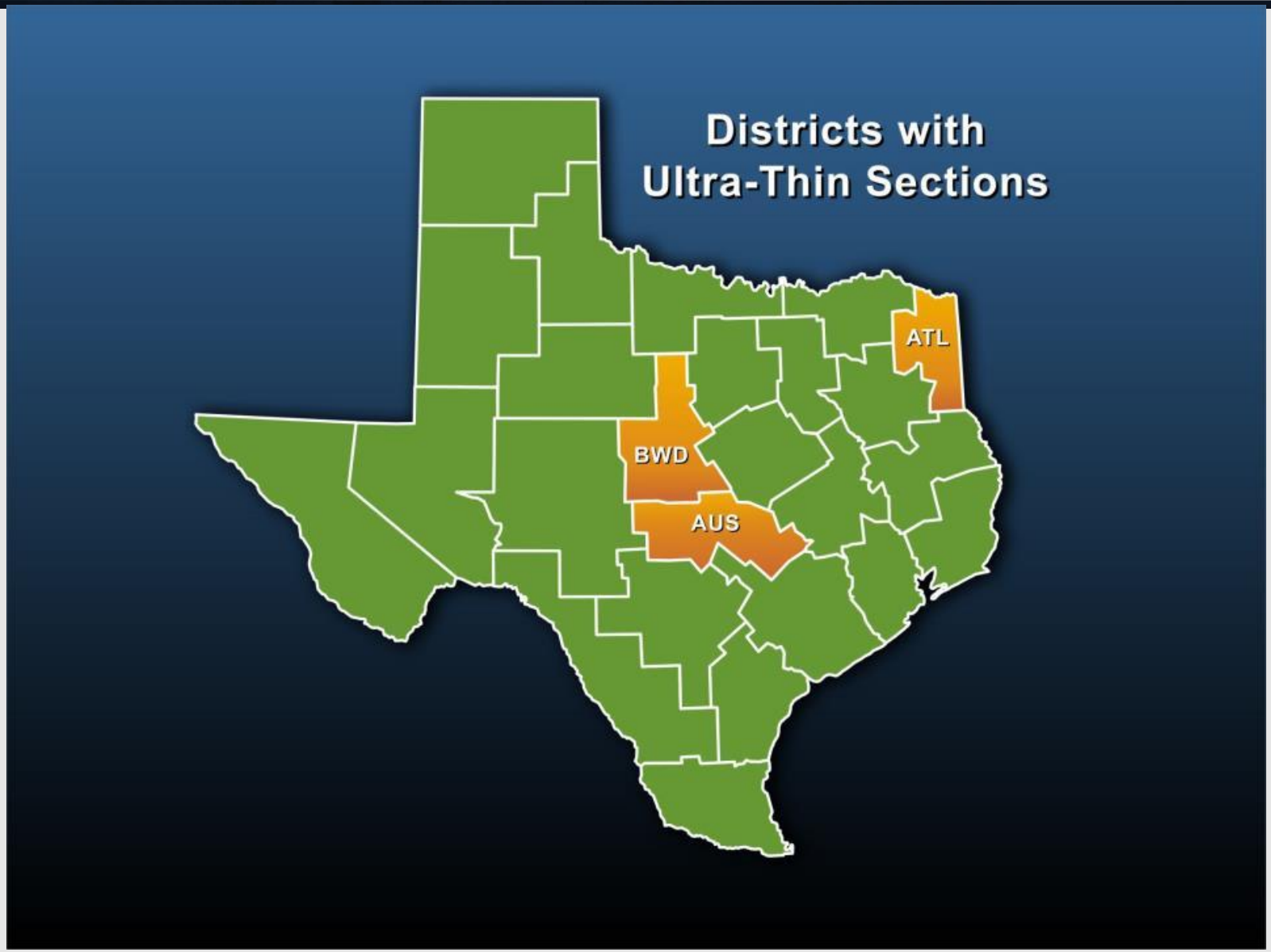
- New Thinlay Mixtures



New Mixtures & Applications



New Mixtures & Applications



New Mixtures & Applications

- Ultra-Thin Overlays (Item 347 TOM-F)
- ¾” to ½” thickness
- When road is not a good candidate for seal coat
  - Good pavement condition
  - Lowest cost application
  - Turning movements
  - Improve skid resistance
  - Crack resistant level up layer

New Mixtures & Applications

- ½ Ultra Thin (TOM-F) on Bleeding Seal Coats
- US 84 (Brownwood District) – First UT mix let outside of Austin

New Mixtures & Applications

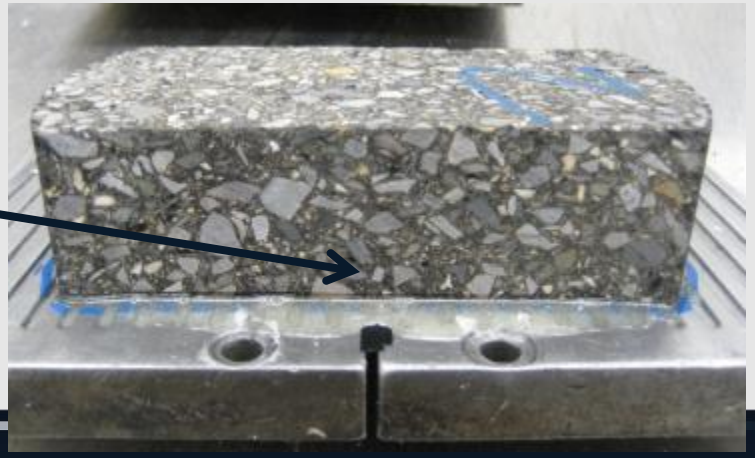
- New Application: 1” PFC-F on Bleeding Seal Coats
- Loop 338 (Odessa District) – wet weather accidents

New Mixtures & Applications

- New Application: TOM/CAM on CRCP
- US 59/IH 69
- ADT = 375,000 vpd @ 10% Truck
- Major freeway for Downtown Houston

New Mixtures & Applications

- All samples > 1000 cycles in OT



New Mixtures & Applications

- US 59/ IH 69 (Houston District) – High Profile

QUESTIONS