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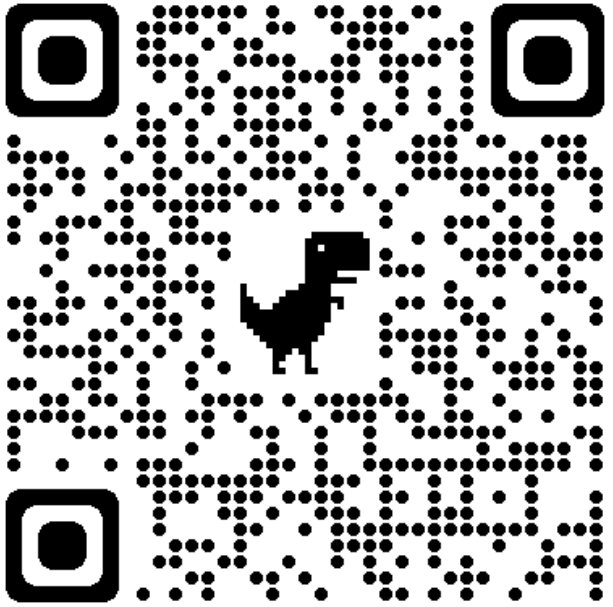
EDC-6 TOPS Initiative - The Roles of HiMA™

Northeastern States Materials Engineers' Association
10/25/2023

Bob Kluttz - Kraton Polymers

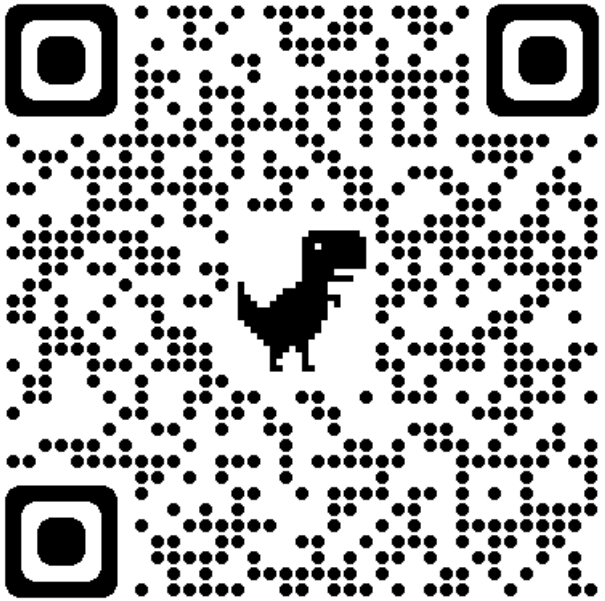
Federal Highway Administration Every Day Counts Program

- A State-based model that identifies and deploys proven, yet underutilized innovations—saving time, money and resources that can be used to deliver more projects.
- Programs run on a two-year cycle starting with EDC-1 in 2011.
- https://www.fhwa.dot.gov/pavement/tops/



Federal Highway Administration
Every Day Counts – 6
Targeted Overlay Pavement Solutions

- Solutions for integrating innovative overlay procedures into practices that can improve performance, lessen traffic impacts, and reduce the cost of pavement ownership.
- Asphalt overlay mixtures have also significantly with the use of stone-matrix asphalt (SMA), polymer-modified asphalt (PMA), and other materials and agents that reduce rutting, increase cracking resistance, and extend pavement life.
- https://www.fhwa.dot.gov/pavement/tops/



Federal Highway Administration
Every Day Counts – 6
Targeted Overlay Pavement Solutions

- Asphalt Rubber Gap-Graded Mix
- Crack Attenuating Mix
- Enhanced Friction Overlays
- Highly Modified Asphalt
- High Performance Thin Overlays
- Open Graded Friction Course
- Stone Matrix Asphalt
- Ultra-Thin Bonded Wearing Course

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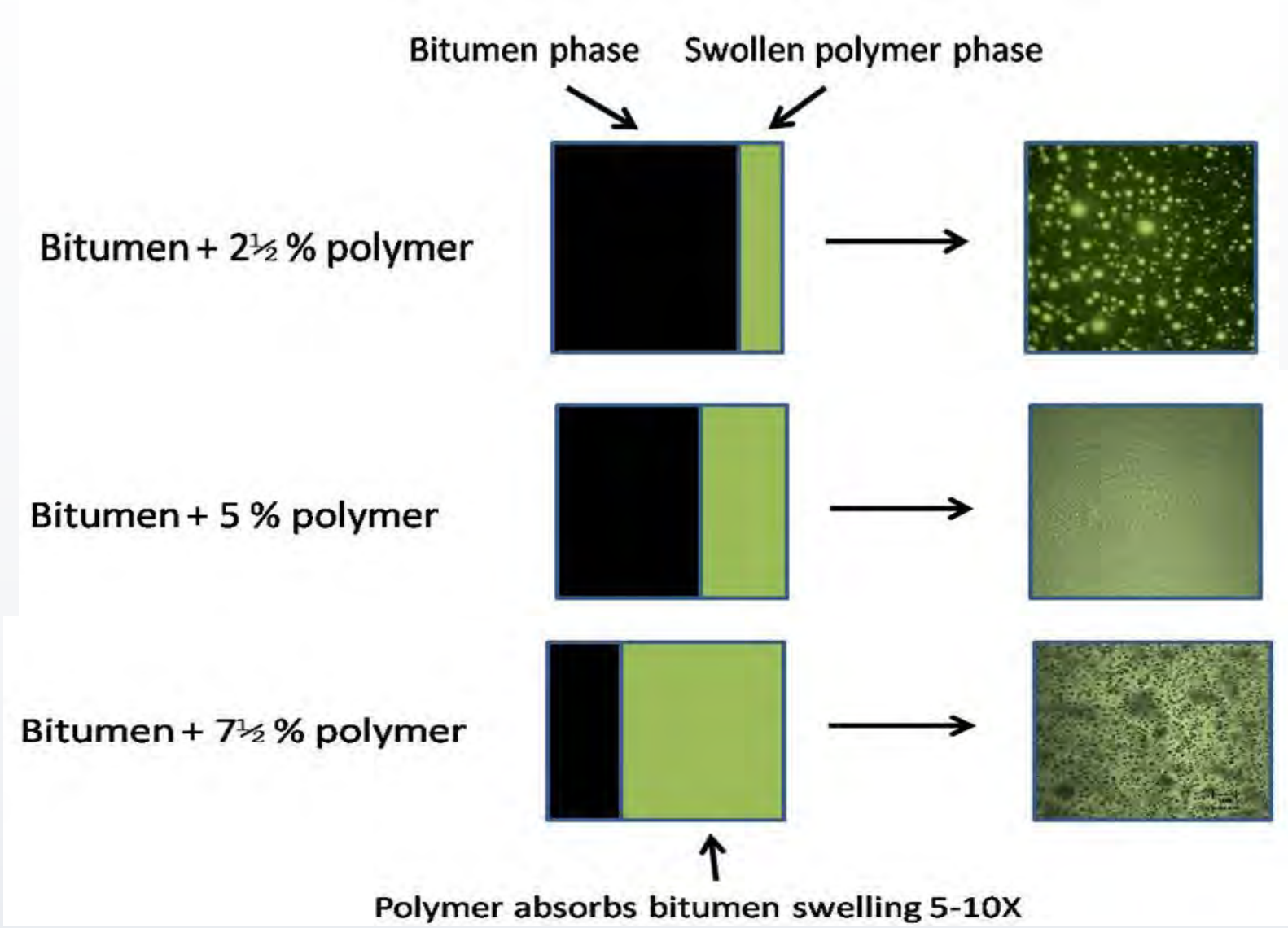
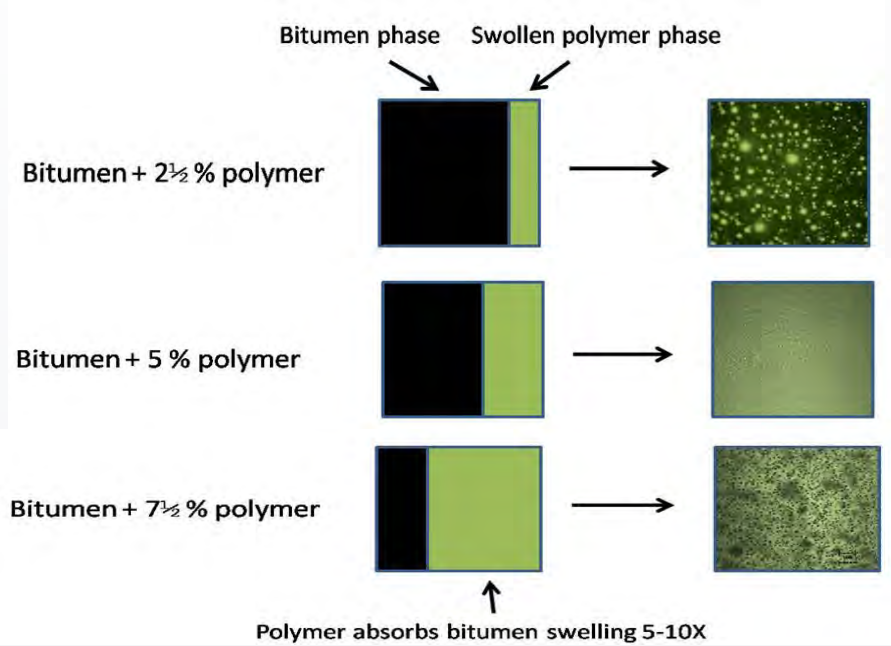
- In fact, HiMA can be applied to most of the TOPS applications.
- It's a multi-purpose tool.

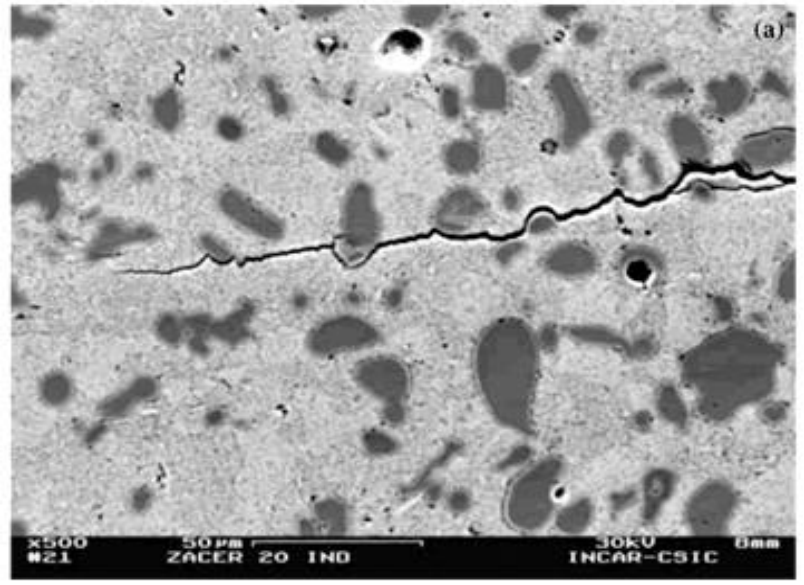
Highly Modified Asphalt - Phase Morphology



What Is Highly Modified Asphalt?



- Highly Modified Asphalt is exactly what it says, asphalt with more than double the normal amount of SBS polymer.
- This gives a much denser polymer network with up to 10X rutting **and** fatigue cracking resistance.



Several million tons in over 100 projects around the world have demonstrated **superior performance** at **reduced thickness**.

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HiMA Specifications North America

Trials
Starting projects
Significant usage

Standard	AASHTO M 320	AASHTO T 301	AASHTO M 332	AASHTO T 350
	PG specification	Elastic Recovery	PG specification	MSCR Recovery
Alabama			PG 76E-22	90%
Alaska			PG 64E-40	90%
Florida			PG 76E-22	90%
Georgia			PG 76E-22	90%
Maine			PG 76E-28	90%
Maryland			PG 76E-28	90%
Pennsylvania			PG 76E-28	90%
Oklahoma			PG 76E-28	95%
Texas			PG 76E-28	90%
Virginia			PG 76E-28	90%
Florida	~~PG 82-22~~	90%		
Iowa	PG 76-34	90%		
Minnesota	PG 76-34	90%		
New Hampshire	PG 76-34	90%		
Ohio	PG 88-22M	90%		
Oregon	PG 76-28	90%		
New York City	PG 76-34	90%		
Utah	PG 76-34	90%		
Vermont	PG 76-34	90%		
Washington	PG 76-34	90%		

HiMA Market Applications – Where Does it Add Value?

- Structural Applications
  - With a sound base, thinner pavements with lower upfront cost
  - Demonstrated in many field applications & Ohio University APLF
  - With weak base, much longer lifetime can be achieved
- Thin Overlays
  - Superior resistance to reflective cracking BUT requires finer, richer mix.
- Preservation Surfacing such as micro surfacing
- Open Grade Mixes for Reduced Raveling
- SAMI Layers, e.g., RIL (OK), CAM (TX)
- High Stress Applications – ramps, intersections
- AASHTOWare® Pavement ME Design works for HiMA designs

TOPS Initiatives

- So which of the TOPS initiatives are being evaluated in Northeast states?
- It’s a smorgasbord.

First off – thanks to a whole bunch of people!

- Bruce Barkovich
- Tom Bennert
- Rick Bradbury
- Mike Byrne
- Mark Brum
- Ron Corun
- Eshan Dave
- Marshal Klinefelter
- Cheng Ling
- Walaa Mogawer
- Ed Nares
- Casey Nash
- Steve Norton
- Dave Powers
- Tim Ramirez
- Mary Robbins
- Mark Shafer
- Christina Skala
- Eric Thibodeau
- Michael Worden

Connecticut, Massachusetts, Rhode Island

- Similar usage and specifications
- Paver Placed Elastomeric Surface Treatment (PPEST) in RI
- PG 73-34 or PG 76E-34 w/ 80% recovery
- Used as high-performance thin overlay
- Questions on most effective lift thickness

Delaware

- Unexpected application!
- Used to mitigate rutting damage from steel-rimmed buggy wheels and horseshoes
- Projects are successful so far.
- Pennsylvania take note!

Maine

- Initial HiMA interest was from NCAT result showing similar cracking resistance to ARGG (gap graded GTR modified).
- First project was a section of ARGG then a section of HiMA in the southbound lane.
- Second year was a HiMA in the northbound lane with a different contractor and binder supplier.
- Lower design voids – 3% – to ensure high binder content. Low risk of rutting due to HiMA stiffness and elasticity.
- Very early for evaluation, but no reported distress to date.
- From the contractor – Production and lay down went well. Compaction and density had no problems if we stayed in the proper temperature zones. Density was easily achieved. Plant production went smoothly after we learned to adjust to the viscosity of the liquid.

Maryland

- Successful overlay projects so far using the VA PG 76E-28 spec
- Limited usage currently with state focus on transit

New Hampshire (similar for Vermont?)

- NHDOT has not performed a TOPS HiMA. They have done two HiMA projects under former FHWA Highways for Life project. NHDOT is planning a TOPS SMA project for next year. NHDOT has utilized an innovative PG 70-34 asphalt mixture with a “recipe” asphalt binder specification (specifying minimum 4% SBS polymer content, so not quite at HiMA level but higher than most typical level, this special provision also requires 4% aromatic oil and binder has to start with neat PG 58-28) to prolong pavement lives and provide added resistance to cracking. Since 2017, 25 paving projects have used this type of mixture.

- Cracking is predominant distress for New Hampshire so that would be the main reason for HiMA application.
- Improved cracking performances that would in-turn result in life cycle cost improvements and reduced maintenance and rehabilitation costs would make HiMA a good choice.
- There were no changes to basic asphalt mixture design (follows standard Superpave mix design procedure).
- Performance has been tracked for the PG 70-34 mixtures since their inception in 2017. These mixtures have shown improved cracking resistances and ride quality as compared to traditional asphalt mixtures.

New York (City)

- Two highlights:

- 50 blocks of 1st Avenue – NJ HPTO mix with ~76E-34 binder, 2014 construction still showing exceptional performance.
- George Washington Bridge – NJ BDWSC mix

- Interest is starting to grow on more city street projects.

- New York State, 100% polymer, PG 64E-22 and 64V-22 give them performance improvement to meet budgetary needs.
- And PG76E-28 for a couple more bridge decks.

New Jersey

- Several applications varying in binder spec from standard to highly modified
- Binder Rich Base Course (BRBC)
- Binder Rich Intermediate Course (BRIC)
- High Performance Thin Overlay (HPTO)
- Bridge Deck Waterproof Surface Course (BDWSC)

Pennsylvania

- Six projects planned, two executed.
- SMA surface mix
- Very early for performance comments
- FHWA grant - $700,000 expected to accelerate evaluation

Florida DOT Experience

- Florida HP = PG 76E-22 accounts for about 4-5% of total state tonnage.
- Primary usage is thin overlays and OGFC.
- Funding research projects to quantify performance and benefits.

Best Practices Per ACAF

- Laydown of HP binders doesn't pose a significant problem as reported thus far, but keep in mind good construction practices:
  - Follow best practices to prevent end of load segregation. HP binders will magnify poor practices!
  - Balance your production rates (plant = trucking = paver = rollers). Keep the mix moving and avoid long stops.
  - Be ready when the trucks arrive on project. Temperature is critical for this mix.
  - Keep compactors tight with paver and adjust rolling pattern as needed to maintain your target density.
- Plant Storage of HP binders is different and requires attention:

Jim Warren, Executive Director, ACAF
https://www.floridaasphalt-digital.com/facb/0119_spring_2019 HP Binder Tech Brief

HP Storage Per ACAF

- Limited shelf life
- Scheduling & frequent communication with binder supplier
- Do not store indefinitely
- Follow supplier specific handling instructions (storage temperature, storage time, circulation, etc.)
- Best practices will vary with supplier

Jim Warren, Executive Director, ACAF

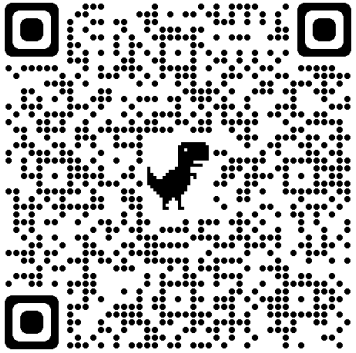
https://www.floridaasphalt-digital.com/facb/0119_spring_2019 HP Binder Tech Brief

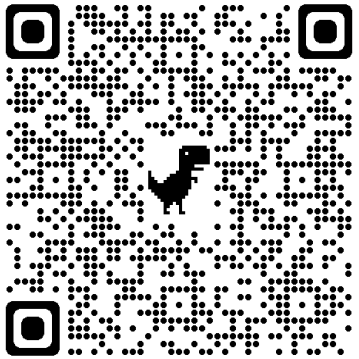
HP Storage Per Kraton

- Some additional recommendations:
- Do not overheat. High temperature accelerates viscosity rise.
- Monitor viscosity daily.
- Warm mix is good.
- Definitely circulate, a sidearm mixer may not be adequate.
- Leftover or high vis product – dilution to PG 76-22 is definitely viable.
- Do not overheat.

DOT Research

- FDOT sponsor, UNR PI 2019
- Recommend increasing structural coefficient 0.44 → 0.54
- https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-be321-rpt.pdf



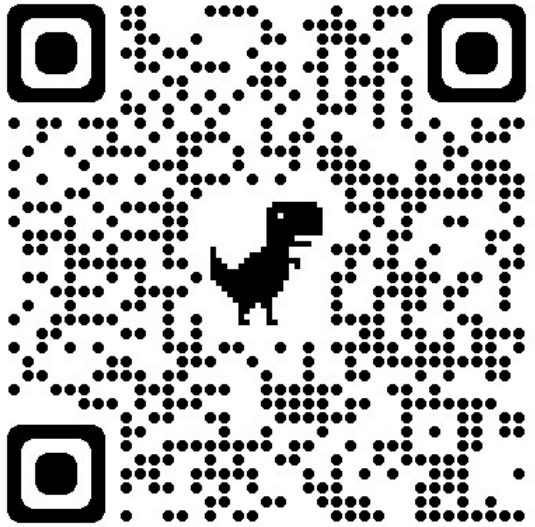


- FDOT sponsor, TTI PI 2019
- HiMA in OGFC up to 50% increase in service life
- https://ntlrepository.blob.core.windows.net/lib/67000/67800/67840/fdot-be287-rpt_Rem.pdf

- VDOT sponsor, VTRC PI 2020
- HiMA in SMA construction up to 34% increase in service life
- http://www.virginiadot.org/vtrc/main/online_reports/pdf/21-r16.pdf

New Development!

- It is my pleasure to report that Asphalt Institute is part of a team recently selected for a 5-year FHWA grant titled *Development and Deployment of Innovative Asphalt Pavement Technologies*. The purpose of the cooperative agreement is to “stimulate, facilitate, and expedite the deployment and rapid adoption of new and innovative technology relating to the design, production, testing, control, construction, and investigation of asphalt pavements.” This is an exciting time to be involved in innovative products that help make asphalt pavements last longer.



Grover Allen – Quarterly Asphalt Institute Engineer’s Report

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Thanks!
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Interlayers

- Primary purpose: to delay or prevent distress from reflecting from underlying pavement/material
- Types:
  - Fabric/geotextiles
    - Woven, non-woven
    - Typically placed over a leveling course
  - Chip seal-type applications
    - Asphalt rubber/stress absorbing membrane interlayer (SAMI)
    - Underseal
  - Hot mix asphalt
    - Strata® asphalt
    - OK Rich intermediate/rich bottom layer (RIL)
    - TX Crack attenuating mix (CAM)

ODOT Specification Requirements, RIL

- Section 411/708, 2019 Standard Specifications
- Laboratory Mix Design Properties:
  - S5 gradation (9.5 mm NMS), min. 5.5% binder content
  - N_{des} = 50 gyrations, 97% G_{mm}, VMA ≥ 15.5%, VFA: 73-79%
  - Hamburg Wheel Tracking: max 12.5 mm deformation after 20,000 cycles
- PG76E-28 binder grade (HiMA)

Table 411:7
Mix Design Properties of Laboratory Molded Non-Superpave Specimens

Property	RIL
Number of SGC Gyrations	50
Required Density, *% of* G_{mm}	97.0
VMA [a], %	≥15.0
TSR minimum	0.80
Draindown, %	—
Permeability, *cm/s* × 10^{-5}	≤12.5
Hamburg rut depth, *mm*	≤12.5[b]

[a] VMA is based on the bulk specific gravity of the aggregates.
[b] Based on PG binder type.

Special Provision 411-015

HiMA Impact-TxDOT “Crack Attenuating Mixture” (CAM)

- Special Specification (2014) Item 3000

Table 5
Master Gradation Bands (% Passing by Weight or Volume) and Volumetric Properties

Sieve Size	Fine Mixture (% Passing by Weight or Volume)
2"	–
1-1/2"	–
1"	–
3/4"	–
1/2"	–
3/8"	98.0–100.0
#4	70.0–90.0
#8	40.0–65.0
Sieve Size	**Fine Mixture (% Passing by Weight or Volume)**
#16	20.0–45.0
#30	10.0–30.0
#50	10.0–20.0
#200	2.0–10.0
Property	**Requirement**
Binder Content	7.0% Min
Design VMA[1], % Min	17.0
Plant-Produced VMA, % Min	16.5

1. Voids in mineral aggregates.

Table 6
Laboratory Mixture Design Properties

Mixture Property	Test Method	Requirement
Design Gyrations (Ndesign)[1]	Tex-241-F	50
Target Laboratory-Molded Density, %	Tex-207-F	98.0
Tensile Strength (dry), psi	Tex-226-F	85–200[2]
Dust/Asphalt Ratio[3]		1.4 Max
Boil Test[4]	Tex-530-C	–
Hamburg Wheel Test Requirements		
High-Temperature Binder Grade	**Test Method**	**Minimum # of Passes[5] @ 0.5" Rut Depth, Tested @122°F**
PG 64 or lower	Tex-242-F	10,000
PG 70		15,000
PG 76 or higher		20,000
Overlay Tester Requirements		
Test Method	**Minimum # of Cycles[5]**	
Tex-248-F	750	

1. May be adjusted within a range of 50–100 gyrations when shown on the plans or allowed by the Engineer.
2. May exceed 200 psi, when approved, and may be waived, when approved.
3. Defined as % passing #200 sieve divided by asphalt content.
4. Used to establish baseline for comparison to production results. May be waived, when approved.
5. May be decreased, when shown on the plans or when directed.

Unlike OK & AL, no general requirement for a particular binder grade

Potential Interlayer Concerns

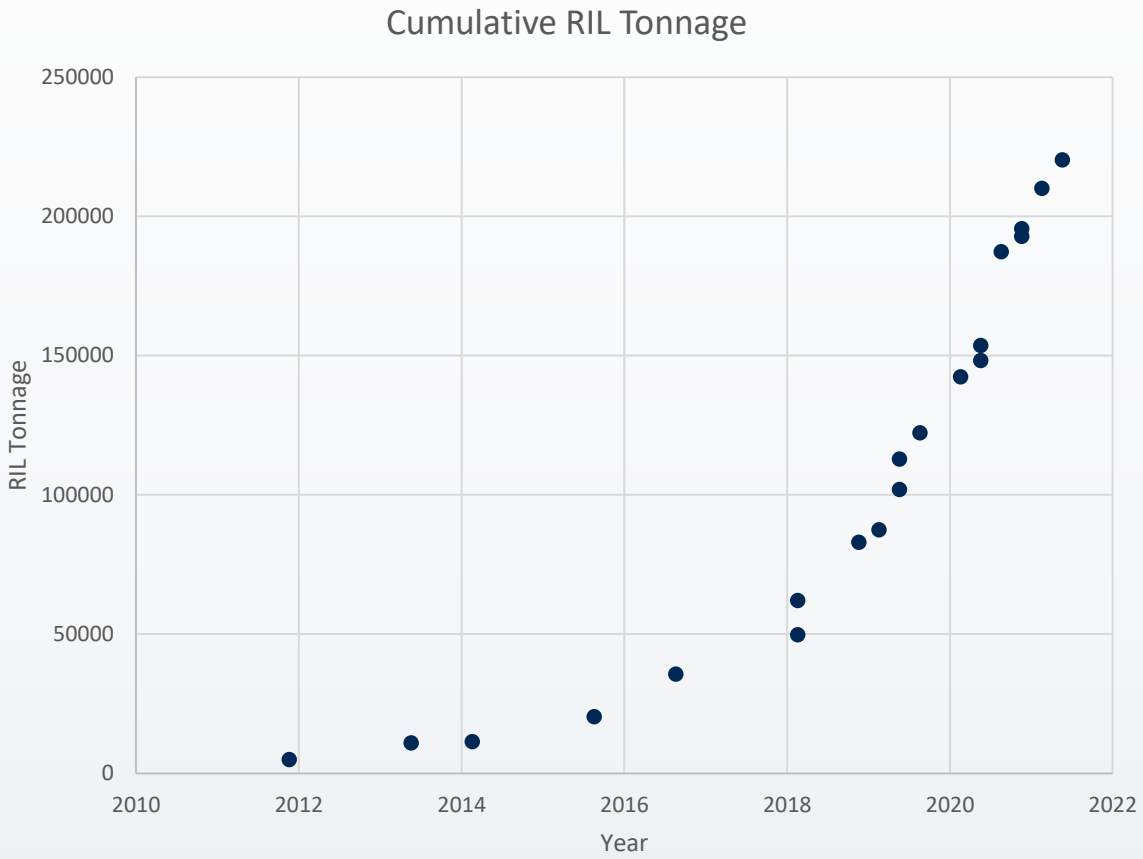
- Multiple operations to mobilize for
  - Added complexity, cost, time
- Specialized work (geotextile placement, asphalt-rubber SAMI application)
- Traffic control during construction
- Cost
- Effectiveness
  - Mixed experience
  - Make sure that the conditions are appropriate
    - Stable underlying structure (minimal vertical movement under loading at cracks)
    - Underlying material resistant to moisture damage
    - Correct any problem with subsurface drainage.

“Rich Intermediate Layer” (RIL)

- ODOT Specifications, Section 411(j)
- Characteristics: Flexible, impermeable, provides structural benefit
- Small nominal maximum aggregate size, high binder content, low air voids mixture using highly modified asphalt binder (HiMA)
  - PG76E-28
- Purpose: to resist reflection of underlying cracks through the surface while providing additional pavement structure and a leveling/profiling opportunity
- First used at the NCAT Test Track in Section N8

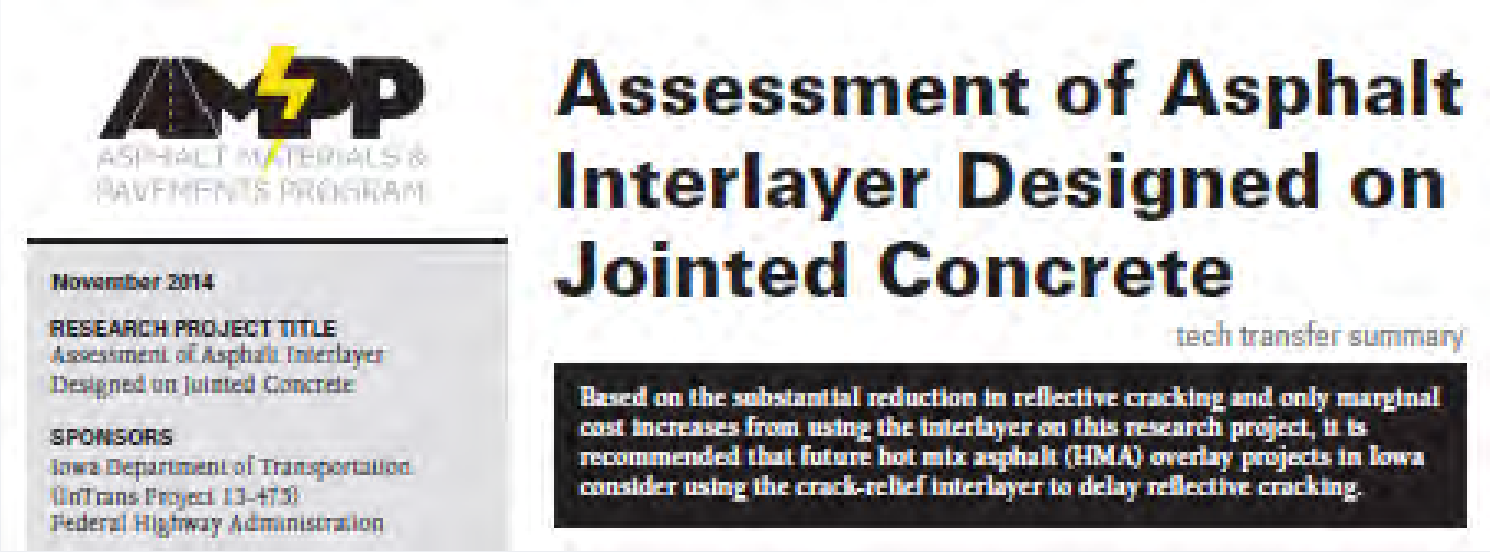
ODOT History of RIL Use: 2012-2022

- Steady increase since 2018
- Used in all ODOT Districts
  - Most in District 1
- Projects ranging from county roads to Interstate highways



Iowa DOT Hot Mix Asphalt Interlayer Specification

- PG 58-34E binder
- No RAP
- AASHTO T-321 Min 100,000 cycles to failure at 2000 microstrain
- In use since 2014, mostly for overlaying jointed concrete pavement



https://intrans.iastate.edu/app/uploads/2018/03/asphalt_interlayer_on_jointed_concrete_t2.pdf

Iowa DOT SS-15010

Sieve Size	Mix Size – Control Points (% Passing)											
	1 inch		3/4 inch		1/2 inch		3/8 inch		HMA Interlayer		HMA Thin Lift	
	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.	min.	max.
1 1/2 inch	100											
1 inch	90	100	100									
3/4 inch		90	90	100	100							
1/2 inch				90	90	100	100					
3/8 inch						90	90	100	100		91	100
No. 4								90	80	100		90
No. 8	19	45	23	49	28	58	32	67	60	85	27	63
No. 16 (1)				28		32			40	70		
No. 30 (2)				24		25			25	55		
No. 50									15	35		
No. 100									8	20		
No. 200	1	7	2	8	2	10	2	10	6	14	2	10

≈ ODOT RIL/S5 Gradation

Table 3

Performance Requirements for HMA Interlayer (2)		
Test	Requirement	Notes
AASHTO T-321	Minimum 100,000 cycles to failure	1

(1) Failure criterion at 2,000 microstrain shall be 50% of the initial flexural stress measured at the 200th load cycle.

(2) Use a PG 58-34E. (Hint: Past experience indicates at least 80%-90% recovery is needed for successful test results) Testing may be verified by the Engineer on field produced mix. Do not open to traffic until mat has cooled to below 200°F.

- N_{des} = 50 gyrations, 98% G_{mm}
- Film Thickness > 8.0 µm

https://iowadot.gov/erl/current/IM/content/510aa.htm

Alabama DOT Projects

1) I-59/-20, Tuscaloosa Co., 2016-7
2) I-459, Jefferson Co., 2018
3) I-85, Macon Co., 2021
4) I-59, Etowah & Dekalb Co.'s, 2022

- 9.5 mm NMS Superpave, designed at 2% air voids requiring HiMA (PG76-22E per ALDOT specs)
- Used to delay/prevent reflection cracking

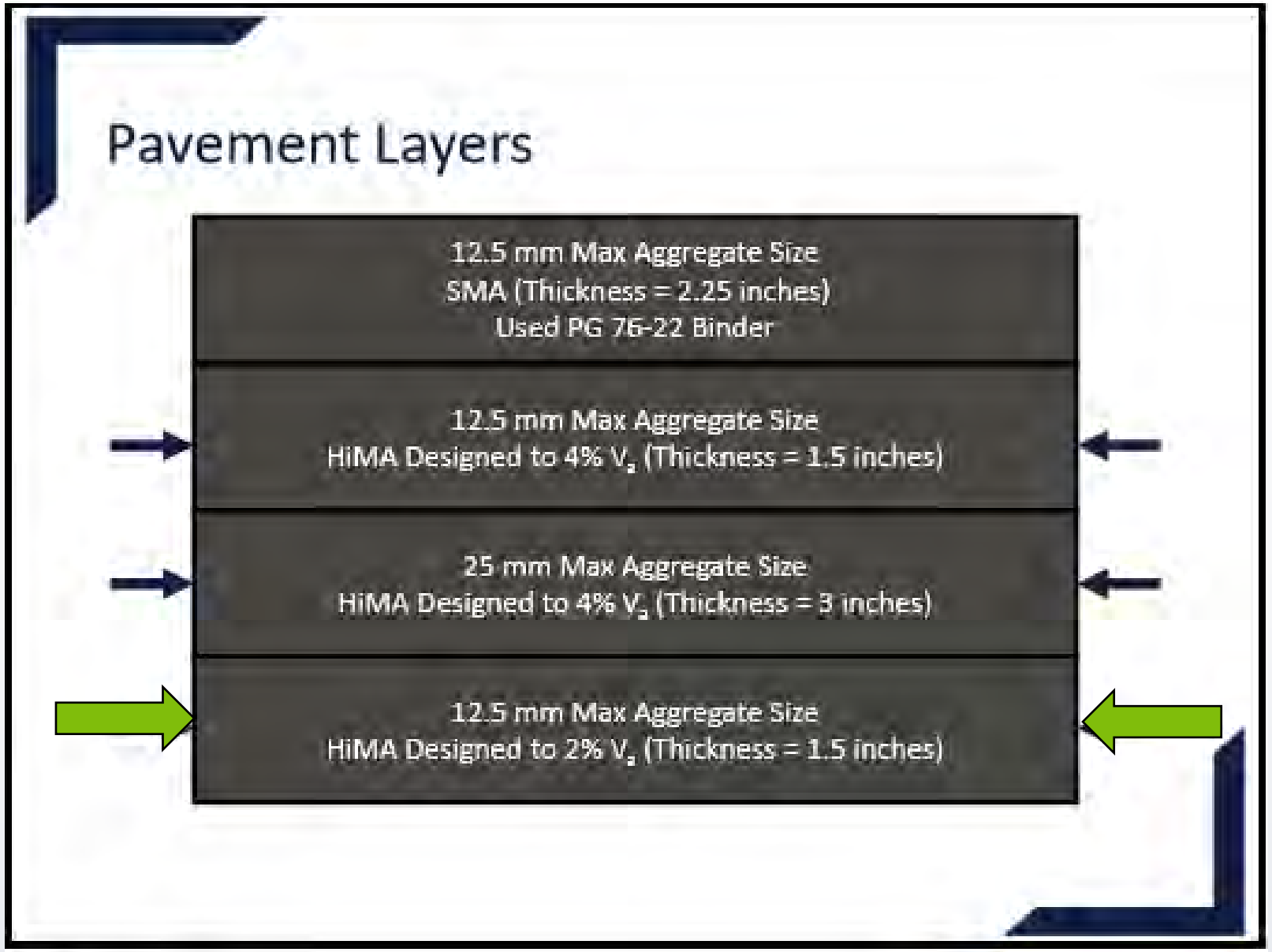
Alabama I-59/20

- Opened in 1970, rehabilitated in 1983, 1990 and 2001
- Extensive longitudinal cracking
  - About 1/3 of cracks extended beyond top 4 inches of pavement
  - Deflection (FWD) analysis suggested the need for additional pavement thickness
- 17 bridges within project limits complicated things
  - Very costly to raise the surface profile to allow for additional structure
  - Estimated to cost almost $8.7 million just to raise bridge surfaces
- Drew from NCAT experience in Section N8

Alabama I-59/20 Rehabilitation

From Braden Smith (Hunt Refining) at 2018 SEAUPG Meeting

Total thickness 8 ¼“

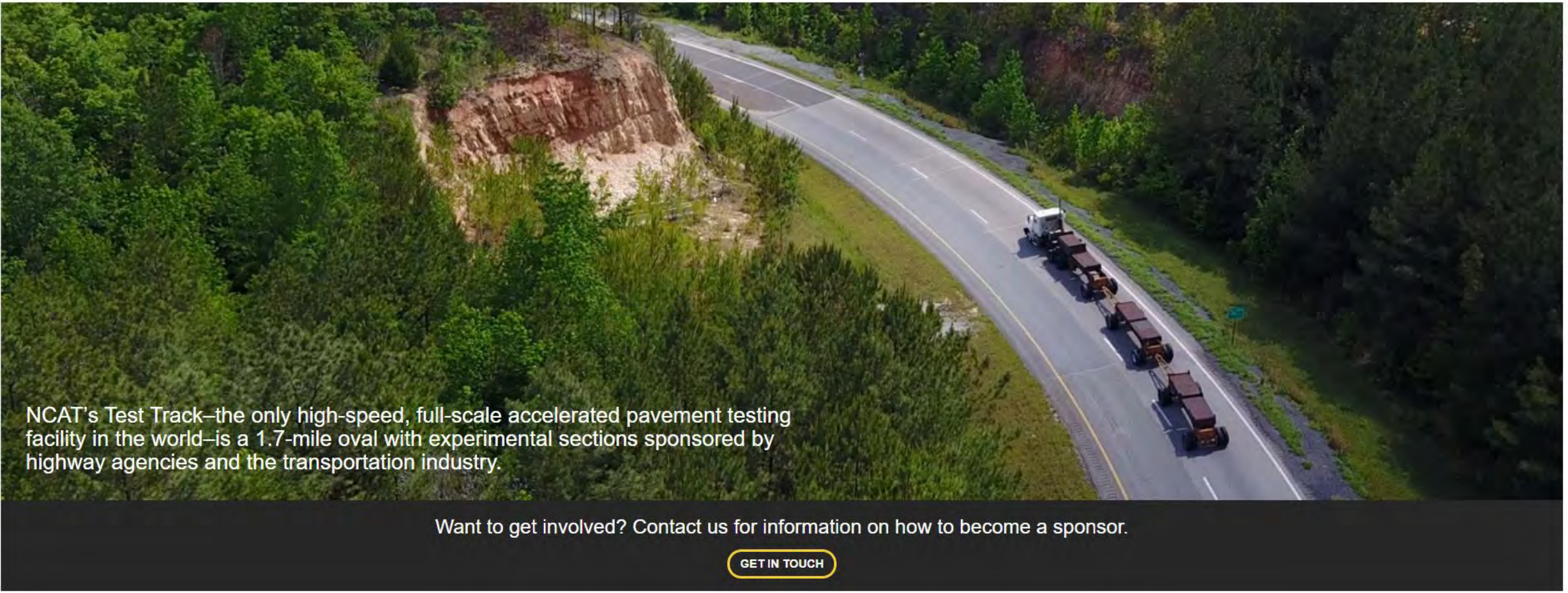


Alabama I-59/20-Conditions

- Opened in 2016, no distress reported by ALDOT in 2020
- Roughness difficult to assess due to bridges, but no change evident
- So far, so good!

National Center for Asphalt Technology
NCAT
at AUBURN UNIVERSITY

About NCAT | Test Track | Pavement Preservation | Education & Training | Our Research



https://www.eng.auburn.edu/research/centers/ncat/testtrack/index.html

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NCAT 2006 Construction, Sections N8 & N9, Oklahoma DOT

- ODOT tested the perpetual pavement concept in anticipation of building SH 152 southwest of OKC
  - Reconstructed the embankment for N8 and N9 to approximate central Oklahoma conditions
  - Both test sections included a “Rich Bottom Layer,” and SMA surface
- Sections N8 (10 in., total) and N9 (14 in., total), Section N9 – no distress, as expected. N8 was severely distressed and required rehabilitation for safety and operational purposes
  - First rehabilitation attempt included milling 5 in., replacing with similar materials as before (as per typical ODOT rehab strategy), placing a geotextile on top of the dense-graded leveling course
  - Cracking observed after 2.7 million ESAL, then deteriorated rapidly requiring additional rehabilitation

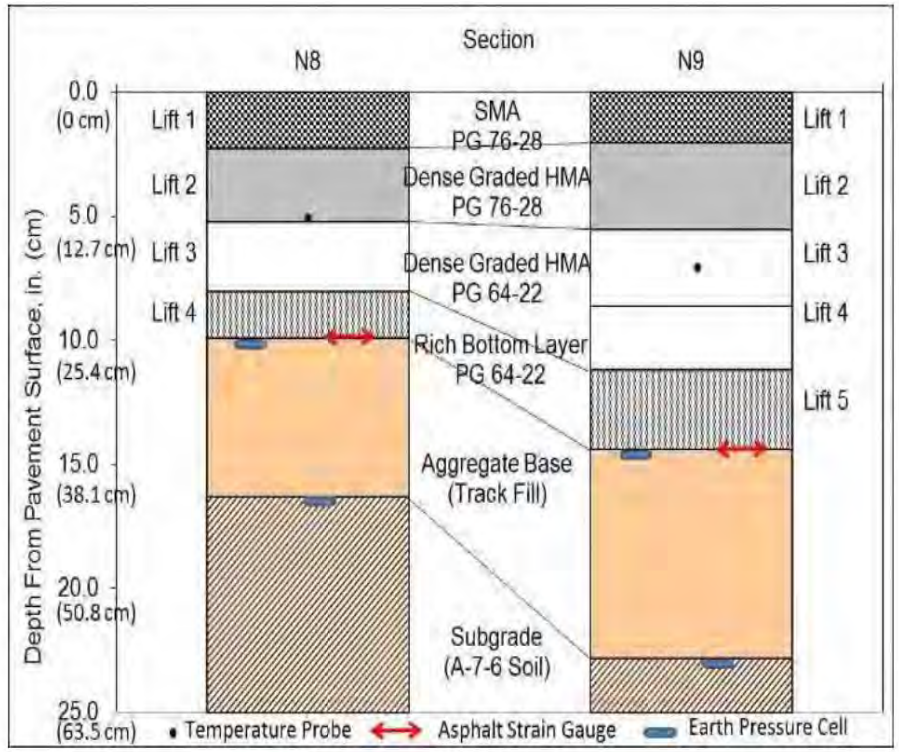

Figure 1 Structural Cross Sections and Instrumentation (*1*)

Timm, D. H., D. Gierhart, and J. R. Willis. Strain Regimes Measured in Two Full Scale Perpetual Pavements. Proc., International Conference on Perpetual Pavement, Columbus, OH., 2009.

NCAT Section N8 – June 29, 2010

- 10” pavement built in Aug. 2006
- 5” rehabilitation in Aug. 2009
- 10 months old

NCAT Section N8, Oklahoma DOT

- Excellent performance observed on the adjacent test section (N7), which was a thin (5¾-inch) pavement using “highly-modified” asphalt (HiMA) binder
- Milled 6 inches, replaced with a like thickness of mixtures using HiMA binder
  - This approach could be done very quickly and easily
  - Included a 1-inch “rich HPM” (RIL) lift to retard reflection cracking-designed to similar volumetric requirements as rich bottom layer mixture.

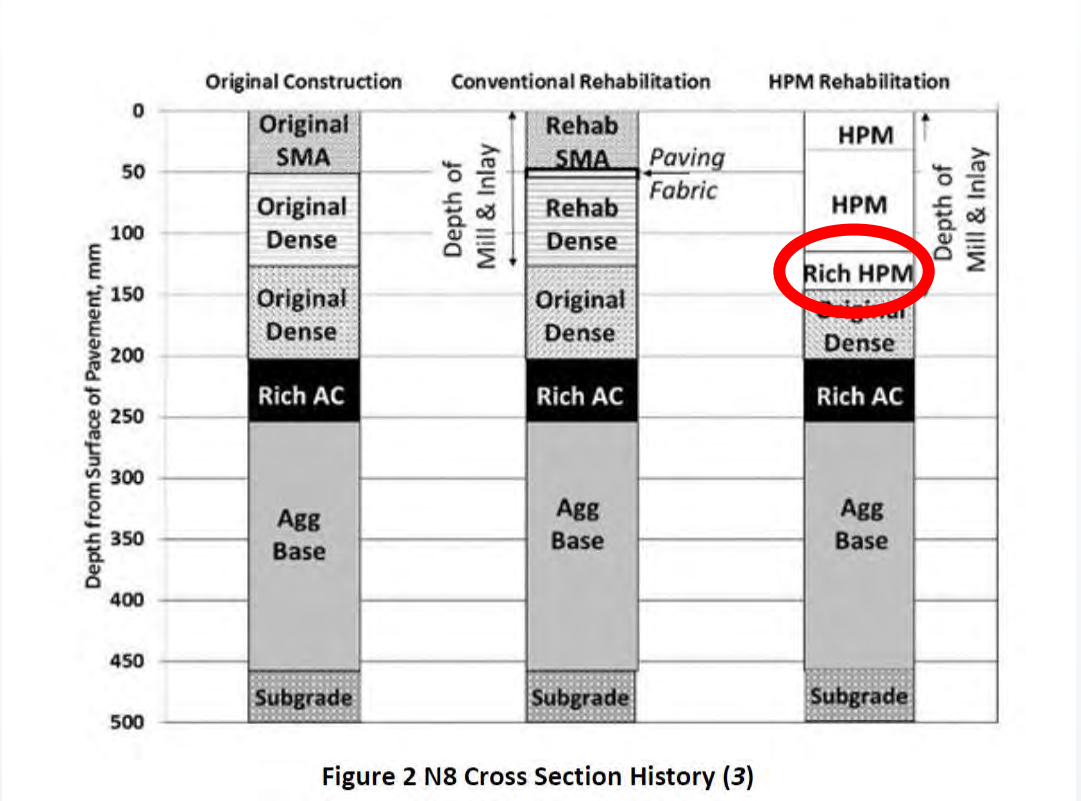

Figure 2 N8 Cross Section History (*3*)

NCAT Report 16-04

https://eng.auburn.edu/research/centers/ncat/files/technical-reports/rep16-04.pdf

NCAT Section N8 Rehabilitation-Results

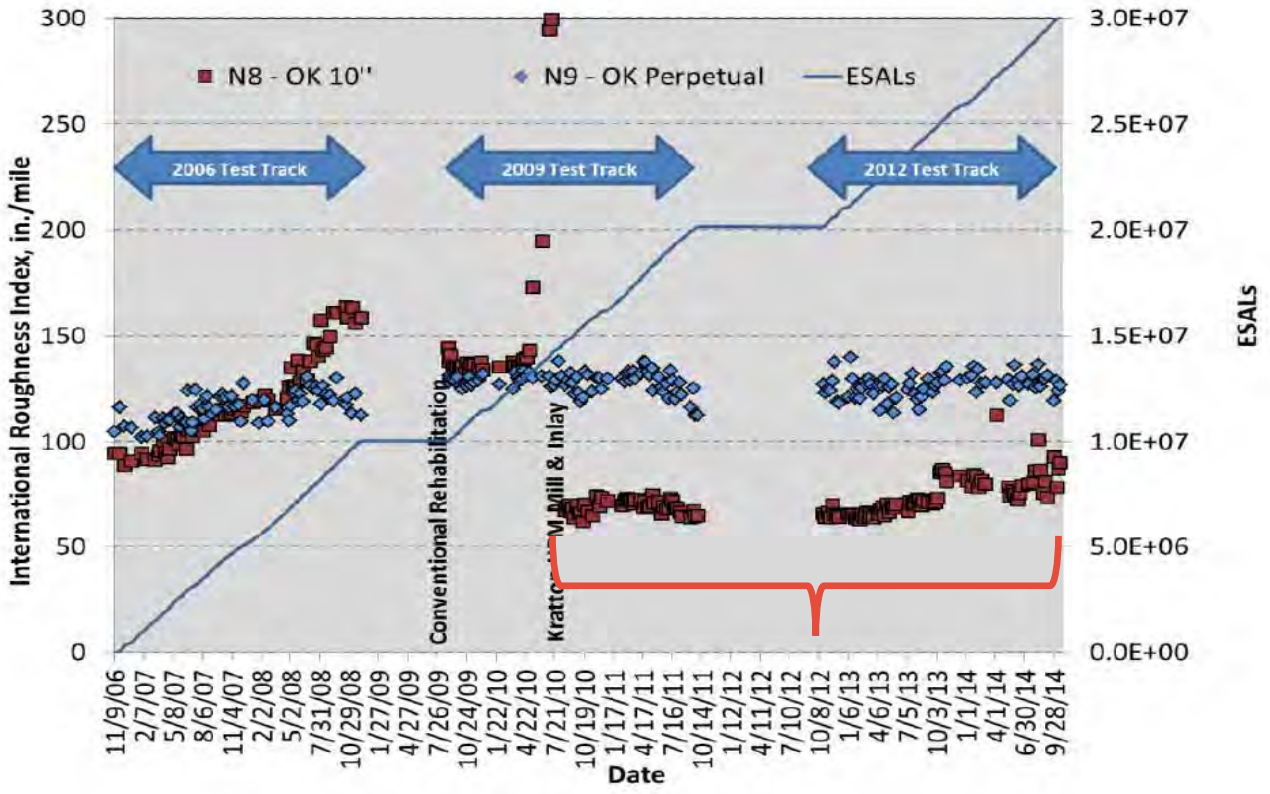

Figure 4 IRI Evaluation of Oklahoma Perpetual Pavement Sections

- Roughness, rutting stabilized after HiMA rehabilitation
- No cracks observed until more than 15 million ESAL
- A viable option for rapid rehabilitation of Interstates or other pavements subjected to heavy vehicle traffic

NCAT Report 16-04
https://www.eng.auburn.edu/research/centers/ncat/files/technical-reports/rep16-04.pdf

I-40, Caddo County (approx. MP 102.2-104.2)

- Feb-April 2012
- Milled 5 inches, replaced with:
  - 1½ in RIL, PG76-28E (HiMA)
  - 5 in S3, PG76-28E, in two lifts
  - 1½ in S5, PG76-28E
  - ¾” OGFC (PG76-28, not HiMA)

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Oklahoma DOT HiMA Specification, PG76E-28

708.03 ASPHALT MATERIALS

Provide asphalt cement in accordance with AASHTO M 320 or M 332 with additional specifications as detailed in Table 708:2 as required by the Contract.

Table 708:2
AASHTO M 332 Requirements for Asphalt Cement

Test	PG 58-28 (PG 58S-22)	PG 64-22 (PG 64S-22)	PG 70-28 (PG 64V-28)	PG 76-28 (PG 64E-28)	**PG 88-28 (PG 76E-28)**
$J_{nr}3.2$, kPa[1]	M 332	M 332	M 332	M 332	M 332
R3.2, %	—	—	≥ 50	≥ 80	≥ 95
PAV DSR	M 332	M 332	M 332	M 332	M 332

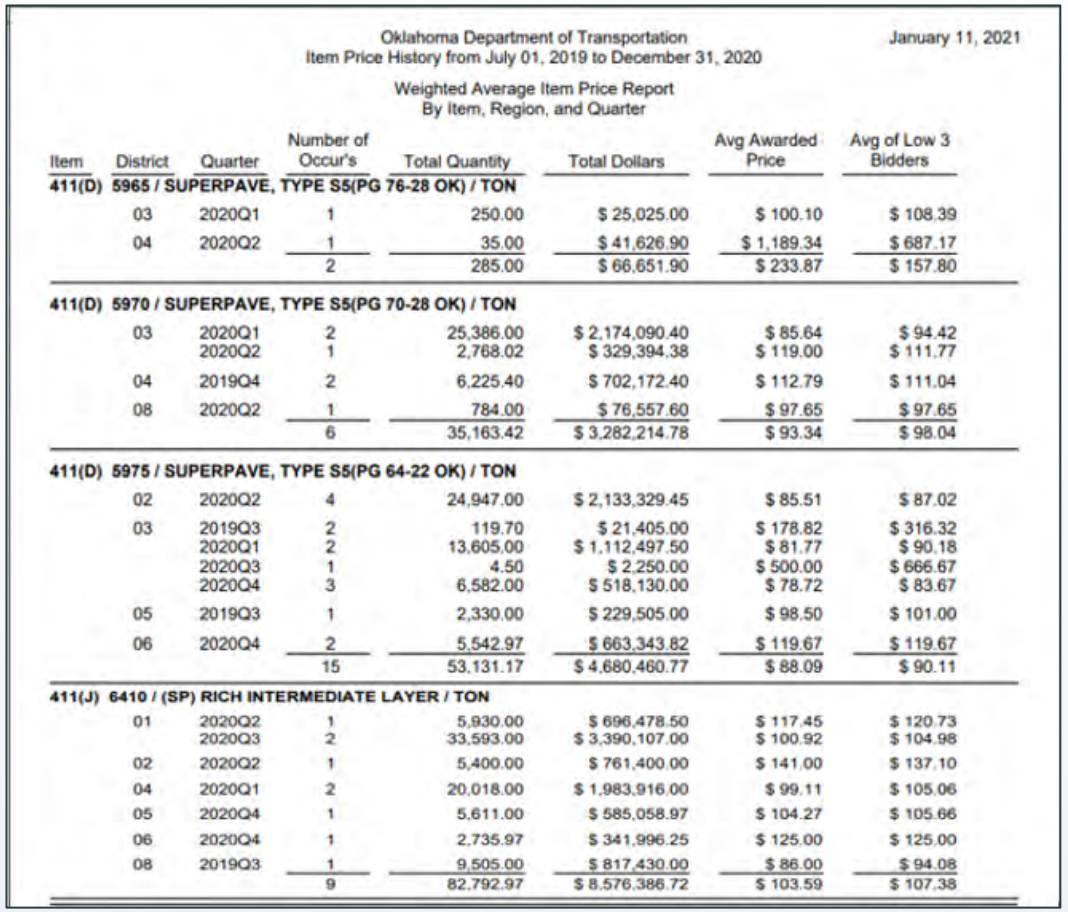
Note: Asphalt binder suppliers will provide handling requirements for their products to the asphalt producer.

[1] May be allowed if 100x micrographs of PG 76E-28 sulfur cured at 2, 4, and 6 hours indicates a uniform dispersion of polymer and approved by the Materials Division Engineer.

Oklahoma DOT Historical Cost Data

- Oklahoma Department of Transportation publishes “Average Price History,” available online
- Compare RIL with Fabric Interlayer + S5 leveling

https://www.odot.org/contracts/avgprices/index.php



Oklahoma Department of Transportation
Item Price History from July 01, 2019 to December 31, 2020
January 11, 2021

Weighted Average Item Price Report
By Item, Region, and Quarter

Item	District	Quarter	Number of Occur's	Total Quantity	Total Dollars	Avg Awarded Price	Avg of Low 3 Bidders
411(D) 5965 / SUPERPAVE, TYPE S5(PG 76-28 OK) / TON							
	03	2020Q1	1	250.00	$ 25,025.00	$ 100.10	$ 108.39
	04	2020Q2	1	35.00	$ 41,626.90	$ 1,189.34	$ 687.17
			2	285.00	$ 66,651.90	$ 233.87	$ 157.80
411(D) 5970 / SUPERPAVE, TYPE S5(PG 70-28 OK) / TON							
	03	2020Q1	2	25,386.00	$ 2,174,090.40	$ 85.64	$ 94.42
		2020Q2	1	2,768.02	$ 329,394.38	$ 119.00	$ 111.77
	04	2019Q4	2	6,225.40	$ 702,172.40	$ 112.79	$ 111.04
	08	2020Q2	1	784.00	$ 76,557.60	$ 97.65	$ 97.65
			6	35,163.42	$ 3,282,214.78	$ 93.34	$ 98.04
411(D) 5975 / SUPERPAVE, TYPE S5(PG 64-22 OK) / TON							
	02	2020Q2	4	24,947.00	$ 2,133,329.45	$ 85.51	$ 87.02
	03	2019Q3	2	119.70	$ 21,405.00	$ 178.82	$ 316.32
		2020Q1	2	13,605.00	$ 1,112,497.50	$ 81.77	$ 90.18
		2020Q3	1	4.50	$ 2,250.00	$ 500.00	$ 666.67
		2020Q4	3	6,582.00	$ 518,130.00	$ 78.72	$ 83.67
	05	2019Q3	1	2,330.00	$ 229,505.00	$ 98.50	$ 101.00
	06	2020Q4	2	5,542.97	$ 663,343.82	$ 119.67	$ 119.67
			15	53,131.17	$ 4,680,460.77	$ 88.09	$ 90.11
411(J) 6410 / (SP) RICH INTERMEDIATE LAYER / TON							
	01	2020Q2	1	5,930.00	$ 696,478.50	$ 117.45	$ 120.73
		2020Q3	2	33,593.00	$ 3,390,107.00	$ 100.92	$ 104.98
	02	2020Q2	1	5,400.00	$ 761,400.00	$ 141.00	$ 137.10
	04	2020Q1	2	20,018.00	$ 1,983,916.00	$ 99.11	$ 105.06
	05	2020Q4	1	5,611.00	$ 585,058.97	$ 104.27	$ 105.66
	06	2020Q4	1	2,735.97	$ 341,996.25	$ 125.00	$ 125.00
	08	2019Q3	1	9,505.00	$ 817,430.00	$ 86.00	$ 94.08
			9	82,792.97	$ 8,576,386.72	$ 103.59	$ 107.38

Cost Comparison: RIL vs. Fabric + Leveling

Item	Low bid	Avg. 3 low bids
S411(J), RIL (1.25”)	$114.10/ton	$120.35/ton
S407(D), Tack Coat (NT), (0.10 gal/sy)	$3.28/gal	$3.32/gal
S409, Fabric	$2.33/sy	$2.28/sy
S409, Bit. Binder	$3.99/gal	$4.54/gal
S411 (D), Type S5 (PG64-22), 1.25”	$80.29/ton	$85.63/ton
S411 (D), Type S5 (PG76-28)	$95.20/ton	$102.40/ton

Source: Oklahoma DOT(https://www.odot.org/contracts/avgprices/index.php), March 14, 2022 Price History

Comparison: RIL vs. Fabric + Leveling*

- RIL Cost = RIL (1.25 in) + Tack (trackless tack @ 0.10 gal/sy)
- Fabric = Fabric + Bituminous Binder (@ 0 .225 gal/sy) + S5 (1.25 in)

Alternative	Low Bid	Avg. 3 lowest
1.25 in Rich Intermediate Layer (RIL)	$8.17/sy	$8.60/sy
Fabric, 1.25 in. S5 (PG64-22)	$8.75/sy	$9.19/sy
Fabric, 1.25 in. S5 (PG76-28)	$9.77/sy	$10.34/sy

*Note that this does not account for differences in mobilization, traffic control or other items

I-40, Caddo County

- Avg. 2020 IRI: 49.97 in/mi (EB), 47.81 in/mi (WB)*
- 2021 AADT = 29,600 with 36% trucks (7% single-unit, 29% combination)

* https://spotlight-okdot.hub.arcgis.com/apps/master-roadway-bridge-data-viewer/explore

“S-Curve” – E

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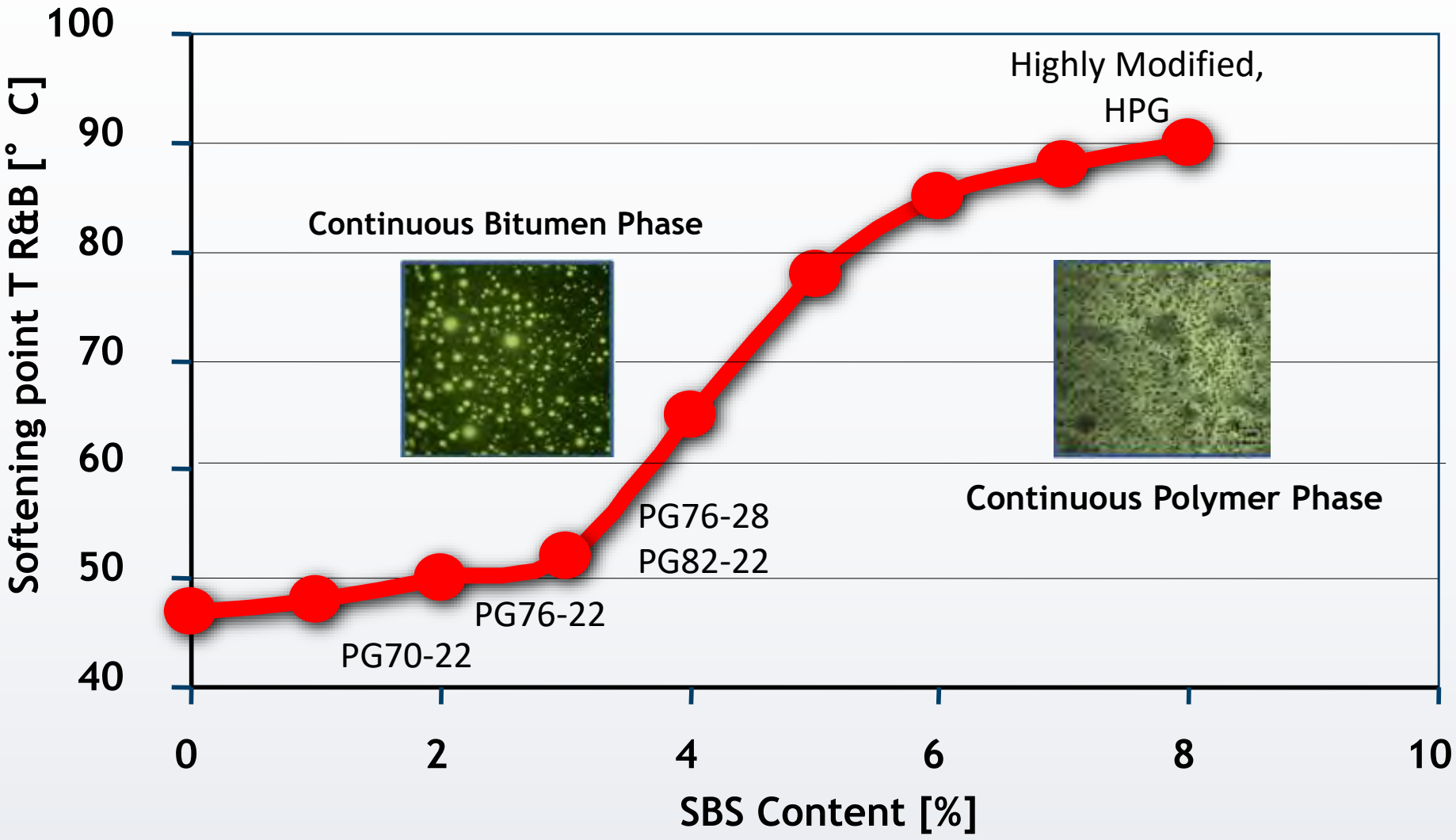
“S-Curve” – Effect of increasing SBS content



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