SMA Success Stories

December 12, 2018

Cynthia Williams - *Illinois Tollway*

Deputy Chief of Program Implementation

Illinois Bituminous Paving Conference

Illinois Tollway

About The Tollway

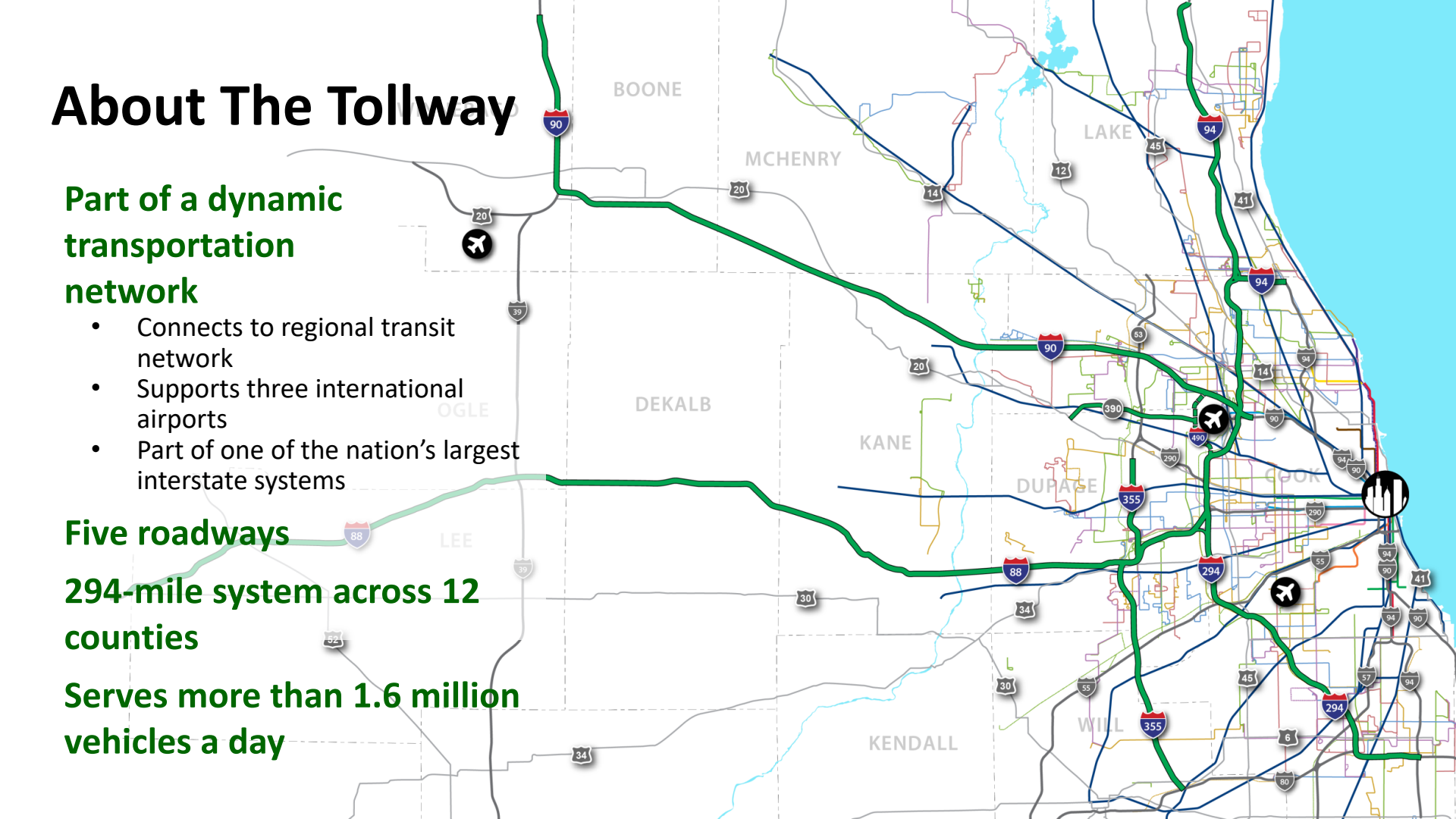
Part of a dynamic transportation network

- Connects to regional transit network
- Supports three international airports
- Part of one of the nation's largest interstate systems

Five roadways

294-mile system across 12 counties

Serves more than 1.6 million vehicles a day



2018 Asphalt Paving Program

323,151 tons of SMA

Item	Depth, inch	Layer Description	Tons	$/Ton
1	2	Stone matrix WMA surface friction course, IL-12.5, N80 (135 Lb/SY/In)	204,771	$81.02
2	2	Stone matrix WMA binder course, IL-12.5, N80 (114 Lb/SY/In)	118,380	$87.07
3	Var	Polymerized WMA binder course (112 Lb/SY/In)	93,782	$80.09
4	Var	WMA surface course (112 Lb/SY/In)	100,596	$93.87
5	3	WMA stabilized subbase (112 Lb/SY/In)	120,291	$76.90
6	6	Full-depth WMA shoulder	235,688	$67.26
7	9	Full-depth WMA shoulder	74,901	$72.18
8	10.25	Full-depth WMA lane pavement	51,171	$81.07
9	9	Full-depth WMA lane pavement	13,126	$74.18
			912,625	

Tollway SMA

Stone-matrix asphalt (SMA) used for all mainline overlays

2008 to 2009 – Full-depth asphalt on the Jane Addams Memorial Tollway (I-90) in Rockford area

2015 – Reagan Memorial Tollway (I-88) rehabilitation

2018 – Veterans Memorial Tollway (I-355) overlay

2018 – I-88 rehabilitation

Seven asphalt producers

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Cost Savings

Item	Depth, inch	Layer Description	Tons	$/Ton
1	2	Stone matrix WMA surface friction course, IL-12.5, N80 (135 Lb/SY/In)	204,771	$81.02
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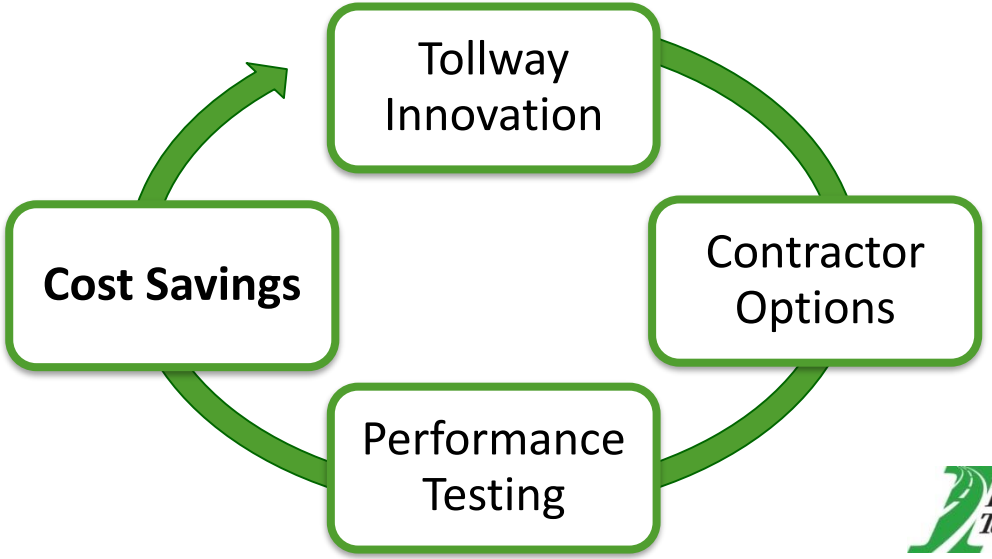
Cost Savings – Created By Innovations

Innovations to date

- Asphalt binder replacement
- Ground tire rubber
- Rejuvenators



Asphalt Binder Replacement

- This table was introduced into Tollway specifications in 2009 – and was for SMA mixes only
- The intent was to incentivize fractionalization of RAP and use of RAS

Reclaimed Material	Binder Replacement %	Asphalt Binder Options
Category I FRAP only	0 -20	SBS PG 76-22
Category I FRAP only or with RAS	21 - 30	SBS PG 70-28
Category I FRAP & RAS	31 - 50	SBS PG 64-34

Asphalt Binder Replacement Now

Reclaimed asphalt material (as allowed in Tollway Tables 7 & 8)		RAP[1/]/FRAP/RAS	FRAP only or with RAS	Category 1 FRAP with RAS
ABR		**0-17%**	**18-33%**	**34-50%[2/]**
Allowable Mix Options	SMA and IL-4.75	SBS 70-28 GTR PG 70-28 PG 58-28 10% Dry GTR		SBS 64-34 GTR PG 64-34 PG 52-342[3/] 10% Dry GTR
	Binder and surface course	PG 58-28		PG 52-34[3/]
	Asphalt stabilized subbase	PG 58-28[4/]		

[1/] RAP not allowed in SMA
[2/] Allowed up to 60 percent ABR on N50 IL 19.0mm binder
[3/] PG 46-34 shall be considered an equivalent to PG 52-34
[4/] Allowed up to 65 percent ABR on asphalt stabilized subbase

Tollway's Approach To Equivalent Performance: *Balanced Mix Design*

Rutting

Hamburg @
20,000 passes

SMA < 6.0mm

Contractor Options

Warm mix
ABR
PG binder grade
SBS polymer
GTR (terminal and dry process)

…and now,
Rejuvenators are coming soon…

Cracking

DCT

SMA $\geq$ 600 J/m^2

Binder Testing - PG Grading

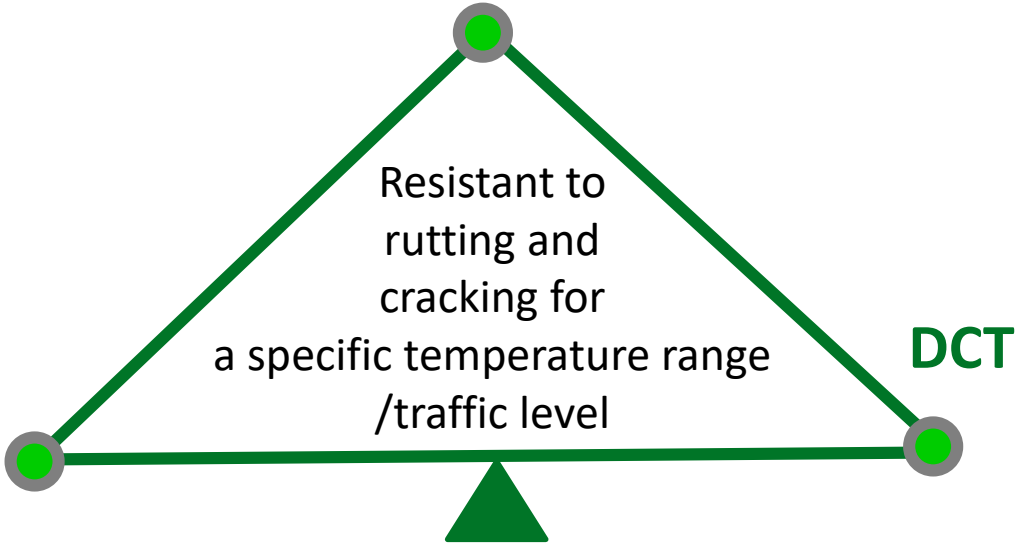
Proposed Specification

Final grade of the extracted binder

Shoulders	PG 64-22
Mainline	PG 70-22
High volume	PG 76-22

Recovered binders - Next step in performance testing

The Future Of Balanced Mix Design



A Look At What Got Us Here



The Tollway's Innovation Evolution

- Warm mix asphalt
- Use of aggregates
- Requirements for recycled materials
- Contractor options
- Performance testing
- RESULT: SMA mixes that are durable and affordable

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SHOULDERS

The Tollway's Sandbox

The History Of WMA

1995 Preliminary lab experiments
1997 German Bitumen Forum
2000 Euroasphalt & Eurobitume Congress
2002 NAPA European Scan Tour
2004 First public demonstration in U.S.
2005 WMA Technical Working Group
2007 AASHTO FHWA International Scan Tour
2008 First U.S. International Conference
2010 FHWA emphasizes as part of EDC
2012 **Tollway mandates all HMA to be WMA**
2015 **Chicago Department of Transportation does too!**

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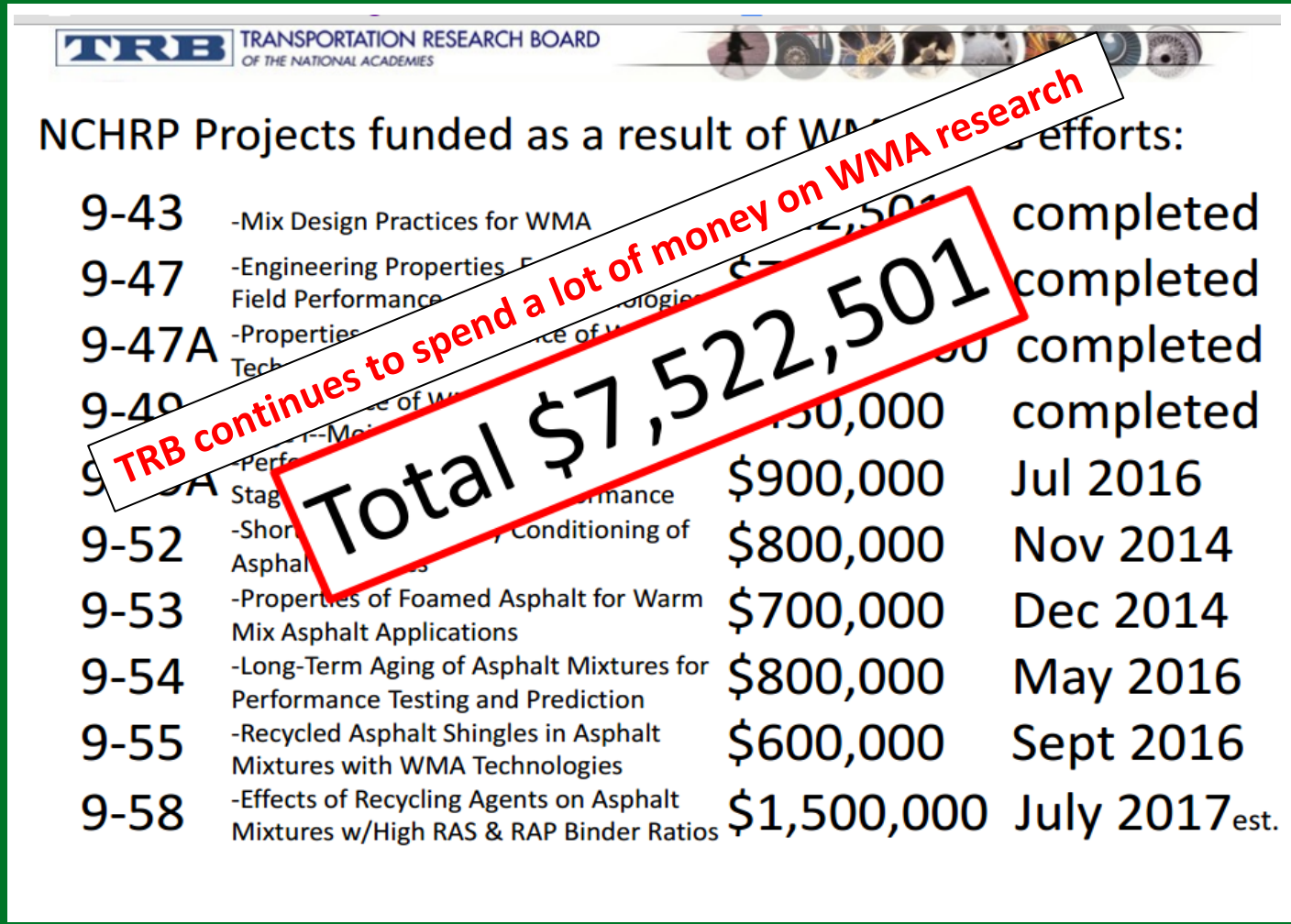
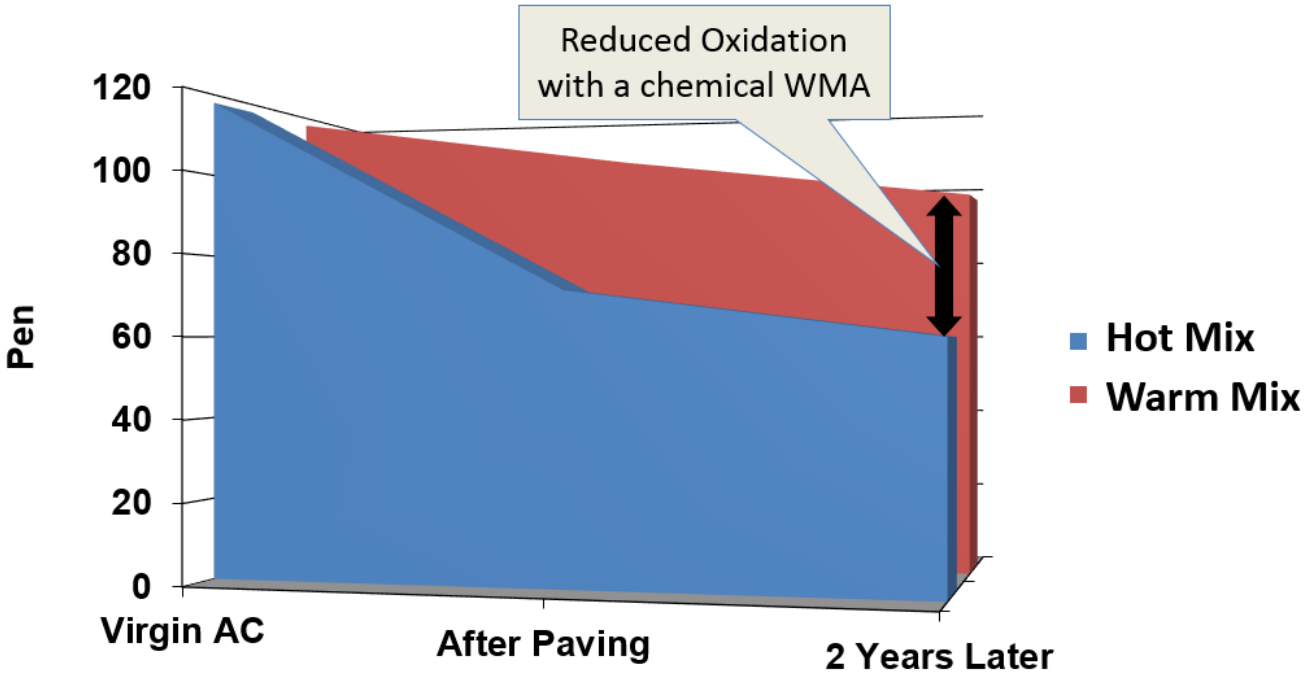
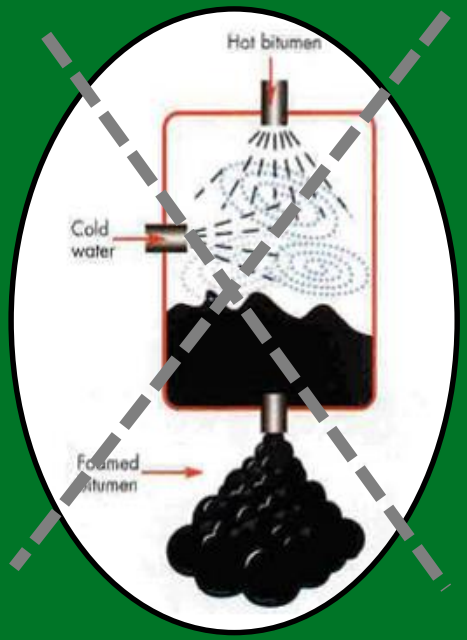
Transportation Research Board



The Most Important Research We Need To Know



Foaming Restrictions



New WMA Specification For 2019

Contractor options

- 0-20 RAP – can use foaming
- Any FRAP, RAS or >20 percent RAP – chemical foaming required

Cold weather

- Chemical foaming only when beyond temperature specifications
- Increase 50 percent additive from mix design target

	WMA Binder Course	WMA Surface Course	WMA IL-4.75
Minimum Ambient Air Temperature (In shade)	32°F and Rising	40°F and Rising	50°F and Rising

Coarse Aggregate For Tollway SMA

Friction surface SMA

- High-traffic pavements and curves
- Coarse aggregate: quartzite, granite, diabase/trap rock, crushed steel slag

Binder SMA and surface SMA

- Coarse aggregate: typically crushed gravel (also surface aggregates)
- 2008 friction evaluation – acceptable for tangents

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Coarse Aggregates For Tollway SMA

- Friction aggregates – Non-Illinois sources, except slag
- Crushed gravel – Southern Wisconsin and Northern Illinois
- 2015 – Evaluated local crushed gravel and dolomite sources
- 2018 – Implemented aggregate testing, including coarse FRAP

Local Aggregates For Tollway SMA

2015 evaluation approach

- Identify potential sources
- Aggregate breakdown
    - Micro-Deval testing

Category I & II FRAP

- Extract using the analyzer
- Run through the Micro Deval

Micro-Deval Of Coarse Aggregates and FRAP

AASHTO T327

- Aggregate breakdown (percent loss) in presence of water
- Good identifier of pavement performance
- “Mini” L.A. Abrasion
- Repeatable test
- Some agencies use in lieu of soundness

Specification – Coarse Aggregate For SMA

L.A. Abrasion – Less than 28 percent loss

Micro-Deval loss

- Single source: less than 12 percent
- Coarse aggregates: design weighted average < 9.5 percent (includes coarse FRAP) – A-OK, proceed with mix design
- If design weighted average 9.5 to 11.9 percent
  - Conduct mix design – optimum AC at 3.5 percent air voids
  - Air voids at optimum AC and $N_{225} \geq 2.0$ percent

How Does This Compare?

NCHRP 557 (aggregate tests for HMA)

- Micro-Deval: Max loss of 15 recommended

AASHTO T327 (Micro-Deval for coarse aggregate)

- 17-18 for HMA surface course (max 21 for lower courses)

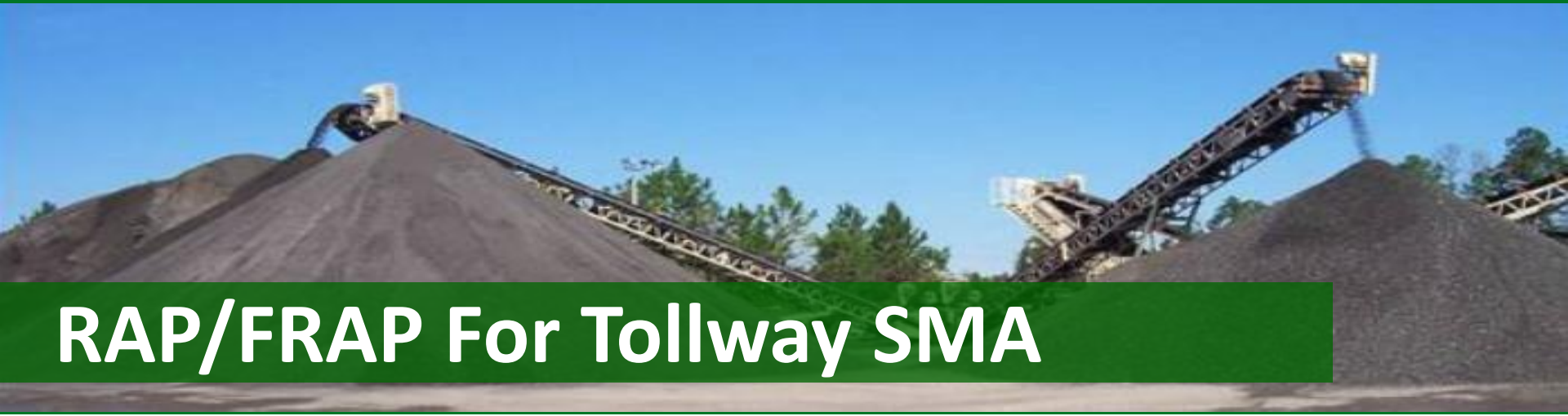
AASHTO M325 (standard for SMA)

- Max L.A. Abrasion = 30
- Higher values have been successful

2018 SMA Mix Designs

- Four contracts
- Seven producers
- 323,151 tons of SMA
- 5 “local” sources used
- Micro Deval = 7.7 to 11.6
- 17 of 18 SMA designs used coarse FRAP

Good Quality RAP



RAP/FRAP For Tollway SMA

Quality sources

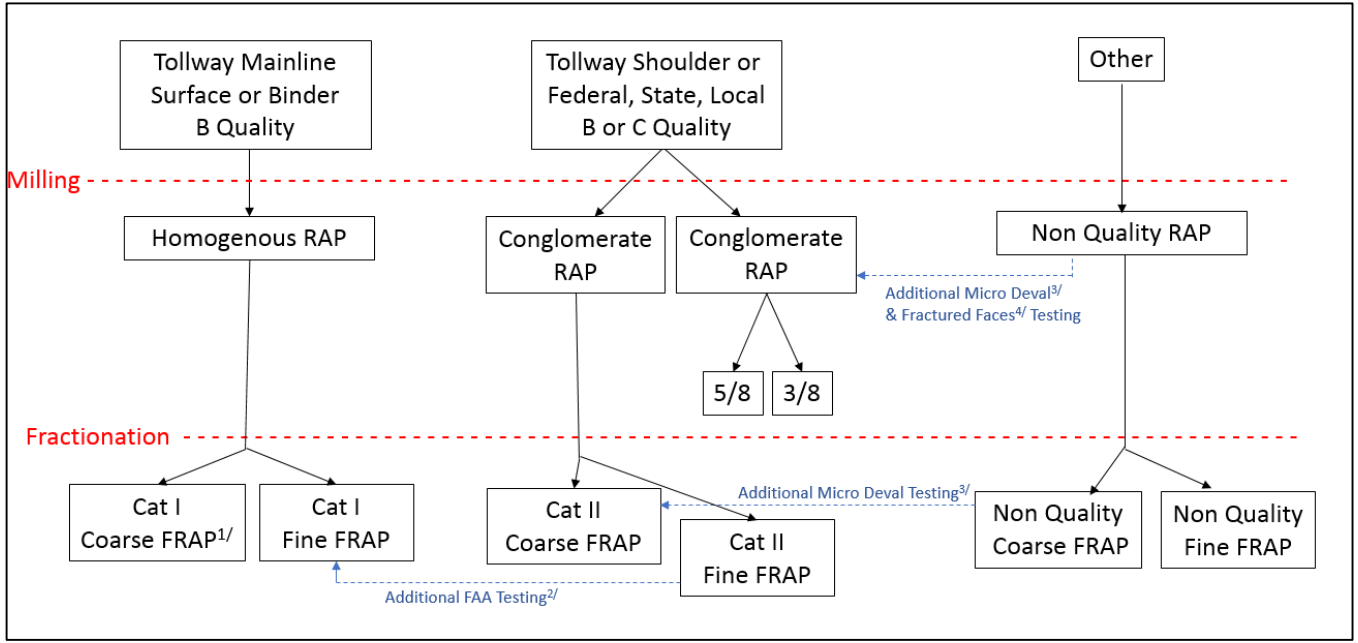
- Tollway requires documentation of the RAP source
- Tollway mainline RAP is separated from shoulder or IDOT mixes

RAP and FRAP production

- RAP/FRAP stockpiles must be tested at a required interval
- All gradation and percent AC must be within a tolerance of mix design JMF targets

Reclaimed Material Processing

Allowable sources and minimum quality for RAP and FRAP stockpiles



Asphalt Binder Replacement

SMA mixes

- Only category I FRAP
- RAS is an option to use instead of fibers
- Terminal or dry process GTR is an option

Reclaimed Asphalt Material (as allowed in Tollway Tables 7 & 8)		RAP[1/]/FRAP/RAS	FRAP only or with RAS	Category 1 FRAP with RAS
ABR		**0-17%**	**18-33%**	**34-50%[2/]**
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	Binder & Surface Course	PG 58-28		PG 52-34[3/]
	Asphalt Stabilized Subbase	PG 58-28[4/]		

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[3/] PG 46-34 shall be considered an equivalent to PG 52-34
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Performance Testing

Hamburg

Mixture Type	# Wheel Passes	Maximum Rut Depth
SMA	20,000	6 mm

DCT

Mixture Type	Minimum Fracture Energy (Tested at -12°C)
SMA – Friction Surface	700 J/m^2
SMA – Surface	650 J/m^2
SMA – Binder	600 J/m^2

N80 IL 12.5 REC SMA - Performance

Contractor	Tollway Mix #	Mixture Description	ABR	Modification	DCT	Hamburg
Plote	90WMA 1841	Binder	50.1	PG 46-34 +10% ECR (dry process)	652 J/m^2	-1.83 @20,000
Curran	90WMA 1833	Surface	37.1	PG 46-34 +10% ECR (dry process)	1510 J/m^2	-5.92 @20,000
Geneva	90WMA 1839	Friction surface	25.8	PG 58-28 +12 GTR (terminal)	967 J/m^2	-4.61mm @20,000
Rock Road	90WMA 1824	Friction surface	37.6	SBS PG 64-34	904 J/m^2	-3.36mm @20,000

Recovered PG Grade Of The Mix

Extraction, recovery and grading of each individual design

This is the ONLY way to know the final PG grade in the pavement

Factors that will affect PG grade

- ABR
- Source of RAS/FRAP
- Virgin binder
- Rejuvenator, warm-mix additive or modifier

Recovered Binders

Next step in performance testing

Proposed new specification on recovered binders

Shoulders	PG 64-22
Mainline	PG 70-22
High volume	PG 76-22

What's the real PG in the road?

N80 IL 12.5 REC SMA – Recovered Grading

Contractor	Tollway Mix #	Mixture Description	ABR	Modification	Recovered Grading
Plote	90WMA 1841	Binder	50.1	PG 46-34 +10% ECR (dry process)	PG 72.5-24.9
Curran	90WMA 1833	Surface	37.1	PG 46-34 +10% ECR (dry process)	PG 70.2 -23.1
Geneva	90WMA 1839	Friction surface	25.8	PG 58-28 +12 GTR (terminal)	PG 73.2-28.9
Rock Road	90WMA 1824	Friction surface	37.6	SBS PG 64-34	PG 78.9-30.2

SMA – Not Only For Roadways Anymore

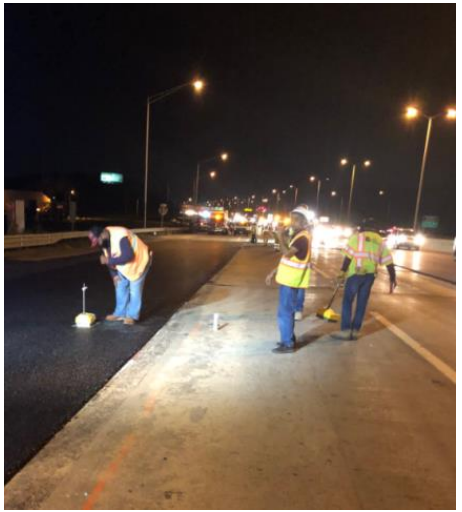
The Mile Long Bridge

Laundry list *(also a mile long)*

- Overlay could not be more than 25 lbs./sf
- Patches of all material types
- Significant MOT restraints
- Had to be completed on a weekend
- And lastly…

The Plan

1. Start with longitudinal joint sealer to seal the deck from water infiltration
2. Pave with 9.5mm SMA over the top using



Material Contractor	Tollway Mix Number	Mixture Description	ABR	AC	DCT	Hamburg
K-Five	90WMA453K	Friction surface	19.9 (11 percent FRAP 2.8 percent RAS)	SBS 70-28	904 J/m^2	-3.69mm @20,000

Success!!

Continued Success!!

An alternative to concrete overlays

Can be used by local agencies

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Tollway Research Opportunities

Research Reports, Approved Materials And CCDD Facilities Lists

Research Request for Proposals
There are no active RRFPs at this time

Research Reports (links)
Evaluation of Field-Produced Hot Mix Asphalt (HMA) Mixtures with Fractionated Recycled Asphalt Pavement (RAP)
Short-Term Performance of Modified Stone Matrix Asphalt (SMA) Produced with Warm Mix Additives
Texturing of Concrete Pavements, NCHRP Report 634
Fractionated Reclaimed Asphalt Pavement (FRAP) as a Coarse Aggregate Replacement in a Ternary Blended Concrete Pavement
Flexural Capacity of Rigid Pavement Concrete Slabs with Recycled Aggregates
Concrete with Steel Furnace Slag and Fractionated Reclaimed Asphalt Pavement

Research Reports (pdf)
High-Performance Concrete for Bridge Decks - Final Report (pdf) ›
Laboratory Investigation of Illinois Tollway SMA Mixtures with Varied Levels of Asphalt Binder Replacement ›

Click below to sign up to learn more about Illinois Tollway research opportunities.

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