Lab Evaluation of Tollway SMA Surface Mixes With Varied ABR Levels

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Tollway's Green Initiatives for Stone Matrix Asphalt (SMA) Mixes Since 2007

- **Adopted ground tire rubber as a modifier**
  - Eliminated the need for fibers in SMA's
- **Introduced fractionated RAP for all mixes**
  - Allowed for higher asphalt binder replacement (ABR) in all FRAP mixes compared to RAP mixes
- **Initiated the use of reclaimed roof shingles (RAS) in Illinois**
  - Increased ABR levels even higher
- **Specified softer binders for higher ABR**
- **Mandated warm mix processes for all mixes**
  - Improved performance at little or no extra cost

Before Implementation, All Green Initiatives Were Tested Through Tollway Research

Tollway Strategy

- Explore new initiatives to make the materials for Tollway pavements / structures more sustainable without sacrifice of quality
- Network and partner with academia, consultants and other agencies on research ideas
- Use Tollway pavements / structures as a test bed for research projects

Implement the Green Initiatives and Watch the Prices Fall

Stone Matrix Asphalt Surface Course Prices

Item	Years of Construction	Unadjusted Ave. Unit Price ($ / Ton)
SMA Surface Course, 12.5mm, N80	2007	> $120.00 – IDOT Dist. 1
"	2008/2009	$114.00 – Tollway
"	2010	$111.00 – Tollway
"	2011	$91.00 – Tollway
"	2015	$96.00 – Tollway

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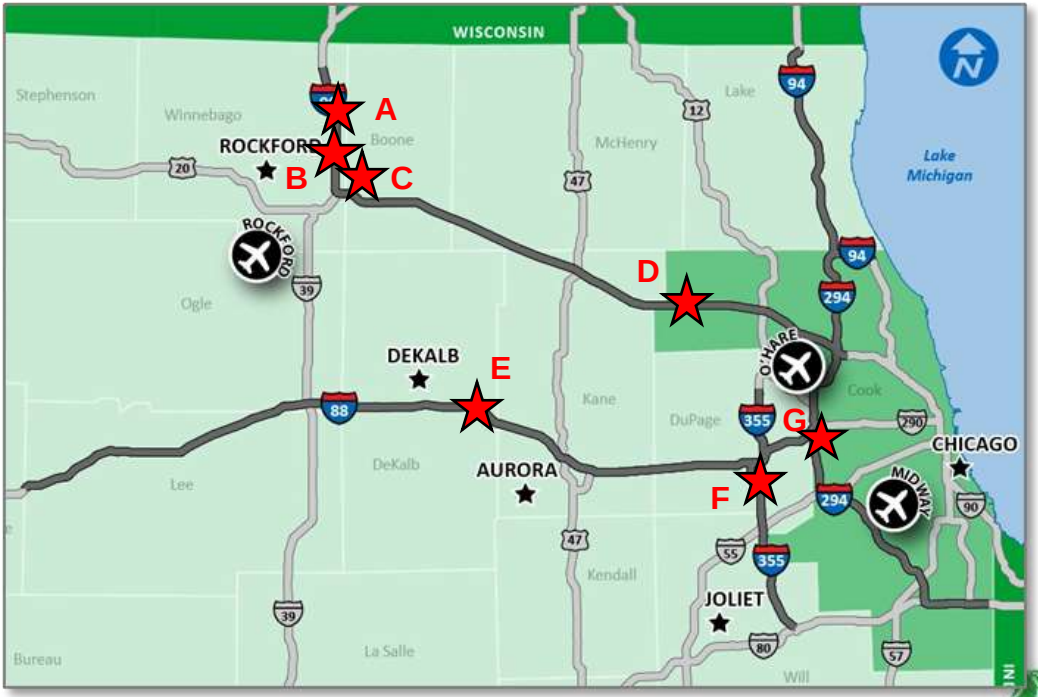
Did the Green Initiatives Maintain or Reduce the Good Performance of SMA Surface Mixes?

Evaluation needed to answer

7 Tollway SMA Surface Course Mixes – Placed 2008 – 2012, Sampled 2015



Detail of SMA Surface Mixes Cored & Evaluated

Mix Location	Year Placed	AC Grade	ABR %	Surface Thickness	Coarse Agg. Type
A. I-90 WB near Rockford	2009	PG 76-22 GTR	14	2”	Cr. Gravel
B. I-90 EB near Rockford	2008	PG 76-22 GTR	16	2”	Diabase
C. I-90 EB near Newberg Rd	2009	PG 76-22 SBS	36*	2”	Quartzite
D. I-90 WB near Rt. 25 / Elgin	2011	PG 70-28 SBS	33*	1.75”	Quartzite
E. I-88 EB East of DeKalb	2012	PG 70-28 SBS	37*	1.5”	Cr. Gravel
F. I-355 NB at 63rd St.	2009	PG 76-22 GTR	0	1.75”	Steel Slag
G. I-294 NB, N. of Cermak	2012	PG 70-28 SBS	31*	2”	Quartzite

*** With RAS**

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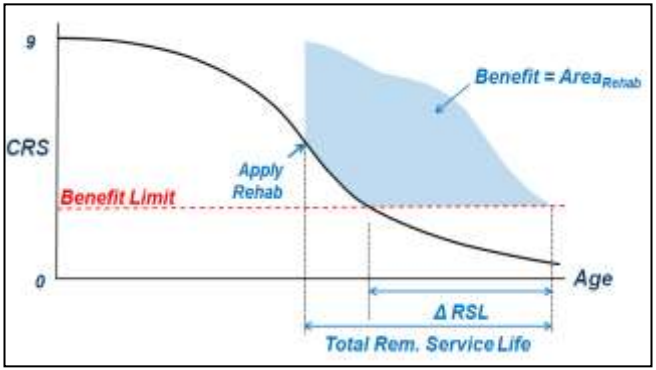
The Evaluation Starts with the Condition Ratings and Remaining Service Life for Each Location

- A pavement management program is of the utmost importance for a large transportation agency
- ARA maintains annual roadway maintenance and rehabilitation records and digital image recordings of the Tollway's pavements and system assets
- All pavement and asset rating occurs in a safe, secure office environment.

The Evaluation Starts with the Condition Ratings and Remaining Service Life for Each Location

- The condition rating survey (CRS) value is on a scale of 1 to 9, with 9 being the best condition possible
- International Roughness Index (IRI) characterizes road roughness
- Distresses and sensor data (including IRI) is used to compute the CRS value
- Projected CRS and traffic data are used to compute a road's remaining service life (RSL)
- The remaining service life estimates how many years before the CRS value will reach 6.5 when repairs or a new overlay will be needed

CRS Rating	General Pavement Condition Category
9.0 to 7.5	Excellent
7.5 to 6.5	Very Good
6.5 to 6.0	Good
6.0 to 5.0	Fair
Less than 5.0	Poor / Failed



2015 Condition Ratings and Remaining Service Life (RSL) of Core Locations & Contract Sections

Mix Location	Year Placed	ABR %	CRS for Contract Section	CRS at Core Location	RSL at Core Location (Years)
A. I-90 WB near Rockford	2009	14	8.0	8.1	15
B. I-90 EB near Rockford	2008	16	7.9	7.8	12
C. I-90 EB near Newberg	2009	36*	8.1	7.7	11
D. I-90 WB near Rt. 25 / Elgin	2011	33*	N.A.	7.2 in 2014	N.A.
E. I-88 EB East of Dekalb	2012	37*	7.8	7.5	7
F. I-355 NB at 63rd St.	2009	0	7.3	7.1	10
G. I-294 NB, N. of Cermak	2012	31*	6.9	6.5	5

*** With RAS**

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A. I-90 WB Near Rockford (SMA w/ 14% ABR, Built in 2009)

CRS	RSL	Distress Observed
8.1 at core 8.0 for section	15 years	Low to medium centerline cracking/separation, isolated longitudinal cracking, isolated patching (truck fire location and WIM failure only)

B. I-90 EB Near Rockford (SMA w/ 16% ABR, Built in 2008)

CRS	RSL	Distress Observed
7.8 at core 7.9 for section	12 years	Low to medium centerline cracking/separation, isolated longitudinal cracking

C. I-90 EB South of Rockford Near Newberg (SMA w/ 36% ABR, with RAS, Built in 2009)

CRS	RSL	Distress Observed
7.7 at core 8.1 for section	11 years	Low to medium centerline cracking/separation and isolated transverse cracking

D. I-90 WB Near Rt. 25 in Elgin (SMA w/ 33% ABR, with RAS, Built in 2011)

CRS	RSL	Distress Observed
7.2 at core in 2014	9 years	Low to medium centerline cracking/separation and frequent transverse reflective cracking

2014 Photo

E. I-88 EB East of DeKalb (SMA w/ 37% ABR, Built in 2012)

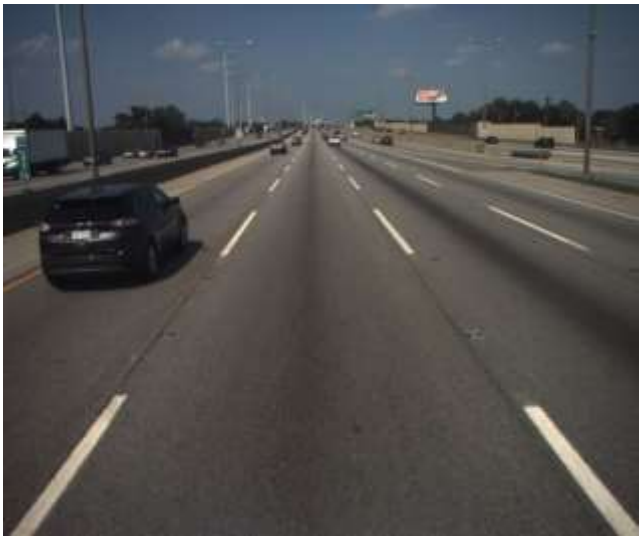
CRS	RSL	Distress Observed
7.5 at core 7.8 for section	7 years	Low to medium centerline cracking/separation, transverse reflective, and longitudinal cracking

F. I-355 NB at 63rd St. (SMA w/ 0% ABR, Built in 2009)

CRS	RSL	Distress Observed
7.1 at core 7.3 for section	10 years	Low centerline deterioration, frequent transverse reflective cracking of medium to high severity

G. I-294 NB North of Cermak Toll Plaza (SMA w/ 31% ABR, Built in 2012)

CRS	RSL	Distress Observed
6.5 at core 6.9 for section	5 years	Frequent transverse reflective cracking of medium severity, low to medium centerline and longitudinal cracking



The Next Step is Performance Measurements of In-Place Materials to Confirm Observations

- **STATE Testing obtained the SMA surface cores from the 7 Tollway locations**
- **STATE Testing performed Hamburg Tracking tests on each core**
  - Rut depths at 20,000 passes ranged from 1.3 to 2.5 mm indicating no rutting potential
- **Cores from each location were provided to the University of Illinois for DC(T) testing to measure cracking resistance**

DC(T) Testing

- **ASTM D7313**
- **Assesses low temperature mix performance, i.e., resistance against:**
  - Thermal cracking
  - Block cracking
- **Gives indicator of reflective crack resistance**

DC(T) – Typical Thresholds

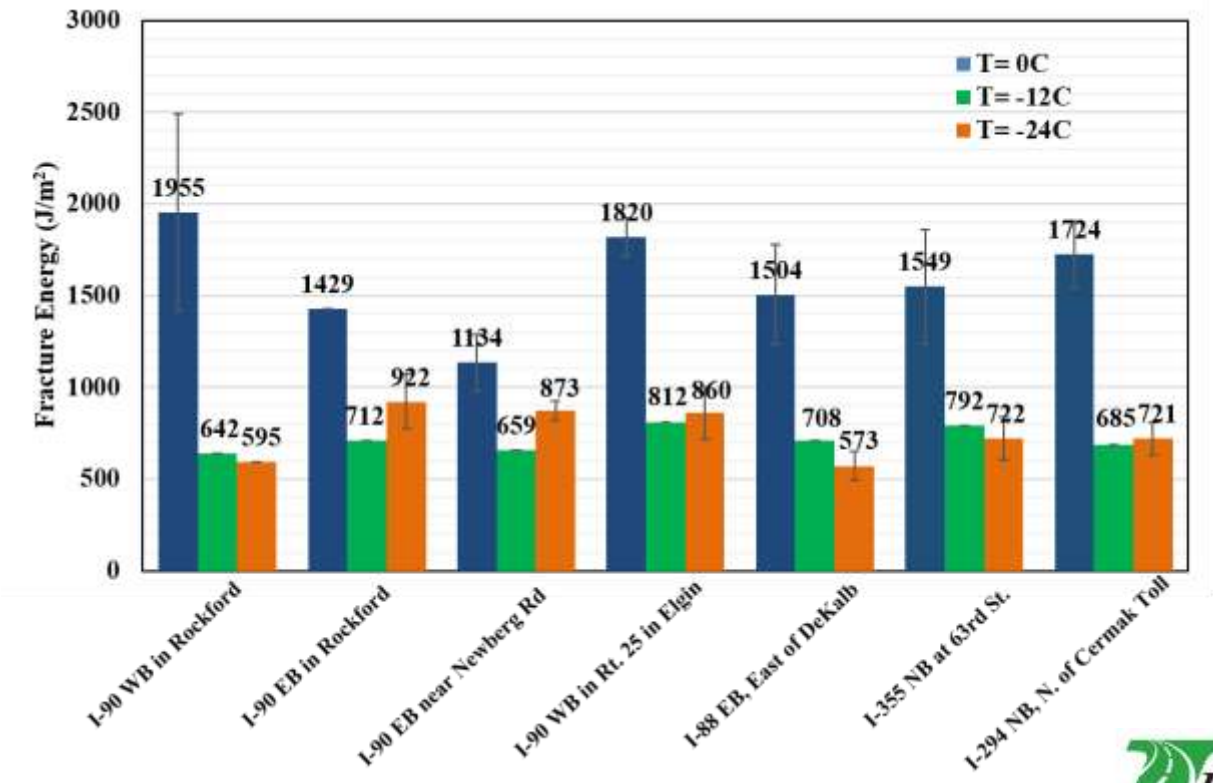
Table 4.2: Recommended Low-Temperature Cracking Specification for Loose Mix

Contents	Project Criticality/ Traffic Level		
	High >30M ESALS	Moderate 10-30M ESALS	Low <10M ESALS
Fracture Energy, minimum (J/m^2), PGLT + 10oC	690	460	400
Predicted Thermal Cracking using ILLI-TC(m/km)	< 4	< 64	Not required

From:
http://www.cts.umn.edu/Publications/ResearchReports/reportdetail.html?id=2178

Implementation: Minnesota, Iowa, Wisconsin, Chicago DOT, O'Hare, Asphalt Institute, Pennsylvania, North Dakota

Fracture Energy Results



Compare green bars to 600 J/m^2

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ILLI-TC Thermal Cracking Modeling

Table 2. Critical events as predicted by ILLI-TC

Section	Cores Location	Input		Output			
		Fracture Energy (J/m^2)	Peak Load (kN)	Calculated Tensile Strength (MPa)	Peak Tensile Stress (MPa)	Peak Tensile Stress/ Tensile strength (%)	Critical Events
A	I-90 WB in Rockford	1275	3.38	4.92	1.15	23.4	0
B	I-90 EB in Rockford	1176	2.76	4.01	0.96	23.9	0
C	I-90 EB near Newberg Rd	1003	3.61	5.25	3.53	67.2	0
D	I-90 WB in Rt. 25 in Elgin	1340	4.10	5.96	1.09	18.3	0
E	I-88 EB, East of DeKalb	1038	2.47	3.59	2.72	75.8	0
F	I-355 NB at 63rd St.	1135	3.64	5.29	2.87	54.3	0
G	I-294 NB, N. of Cermak Toll	1222	2.84	4.13	2.32	56.2	0

Bracketing Performance

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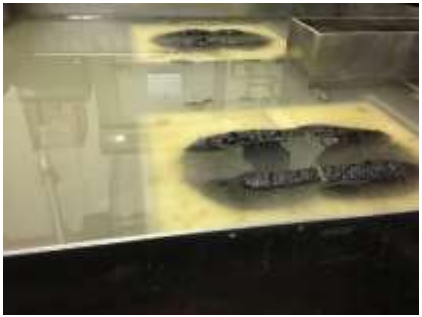
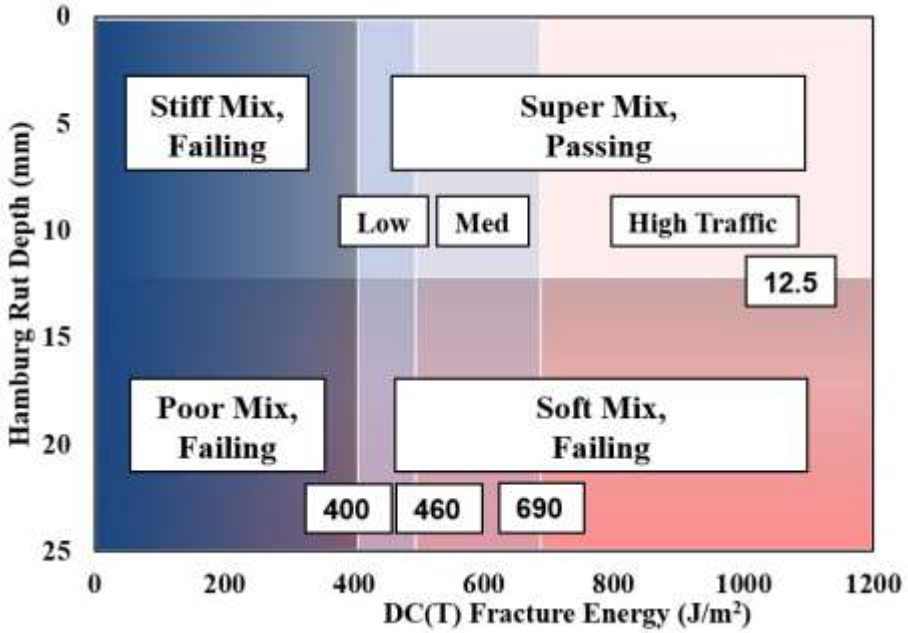


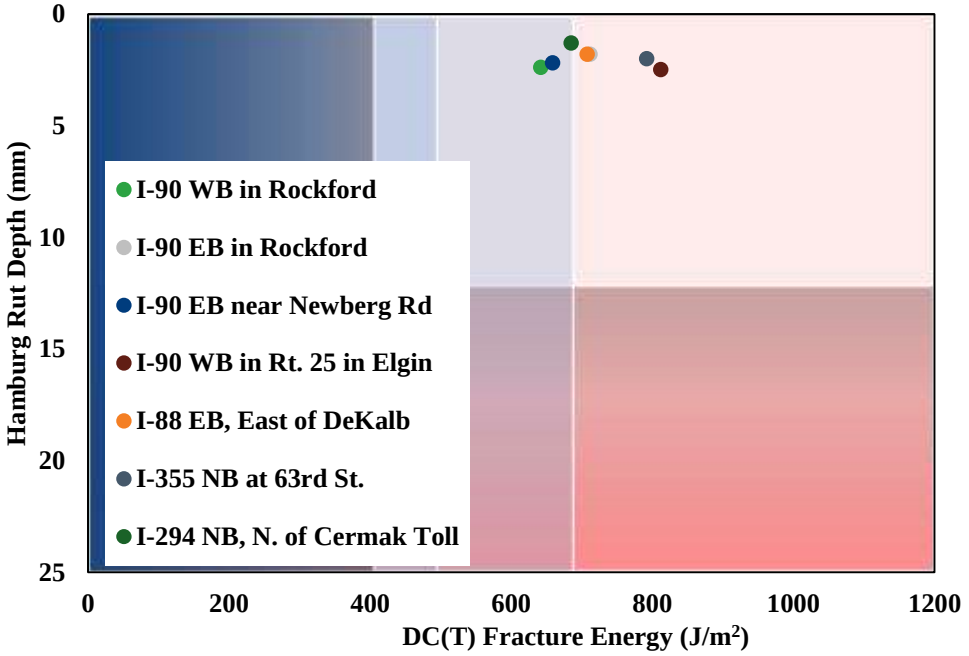
Hamburg

DC(T)

Hamburg-DC(T) Plot



Hamburg-DC(T) Plot



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Thank you