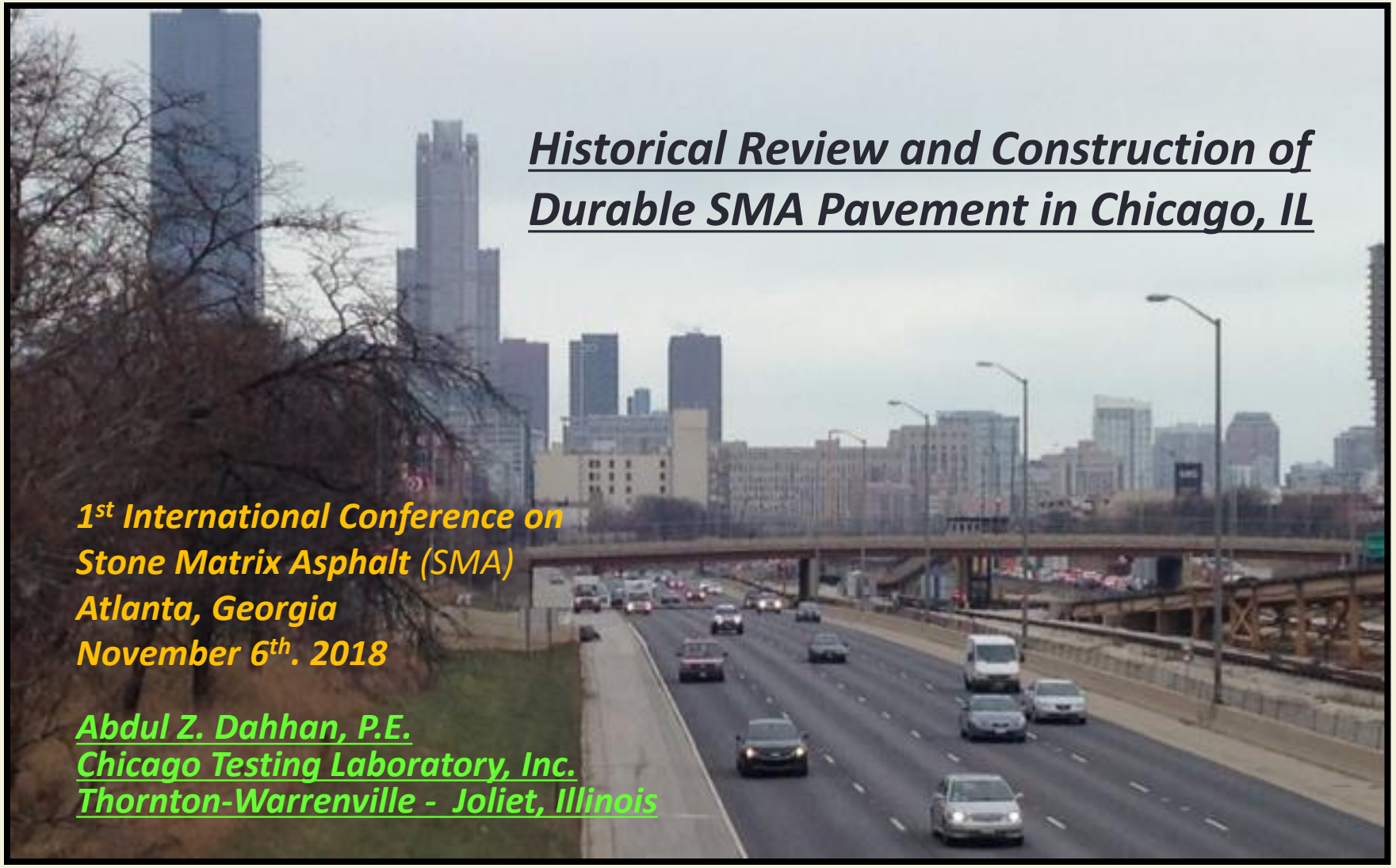


Historical Review and Construction of Durable SMA Pavement in Chicago, IL

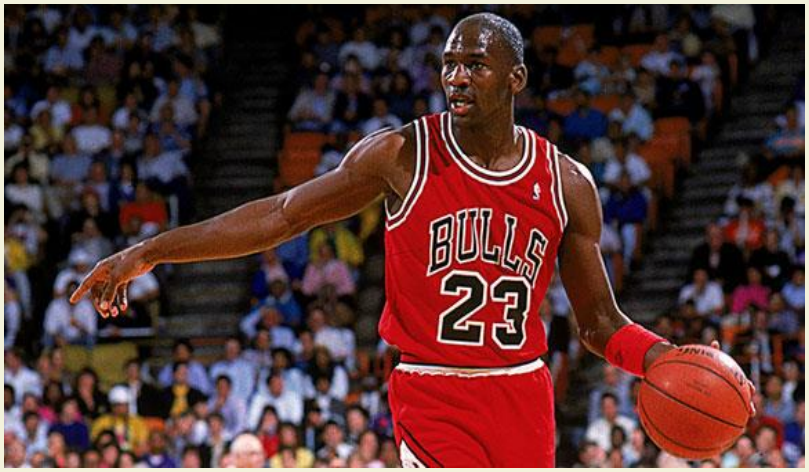
1st International Conference on
Stone Matrix Asphalt (SMA)
Atlanta, Georgia
November 6th. 2018

Abdul Z. Dahhan, P.E.
Chicago Testing Laboratory, Inc.
Thornton-Warrenville - Joliet, Illinois

Chicago Testing Laboratory, Inc.

1

Greetings from Chicago



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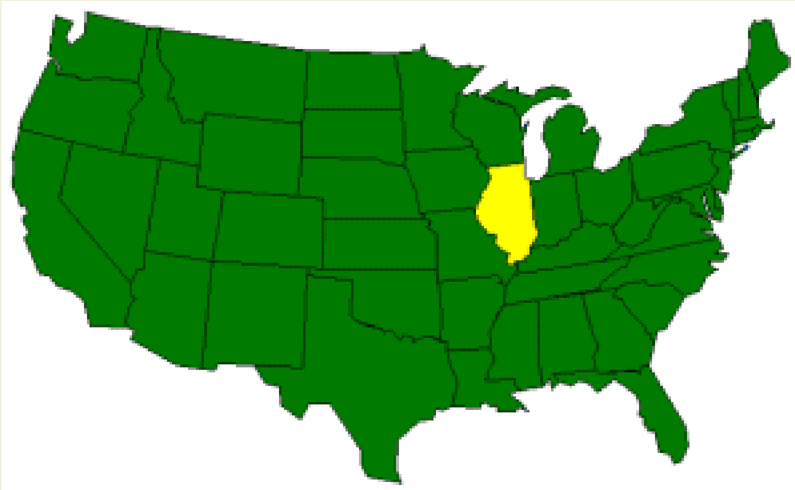
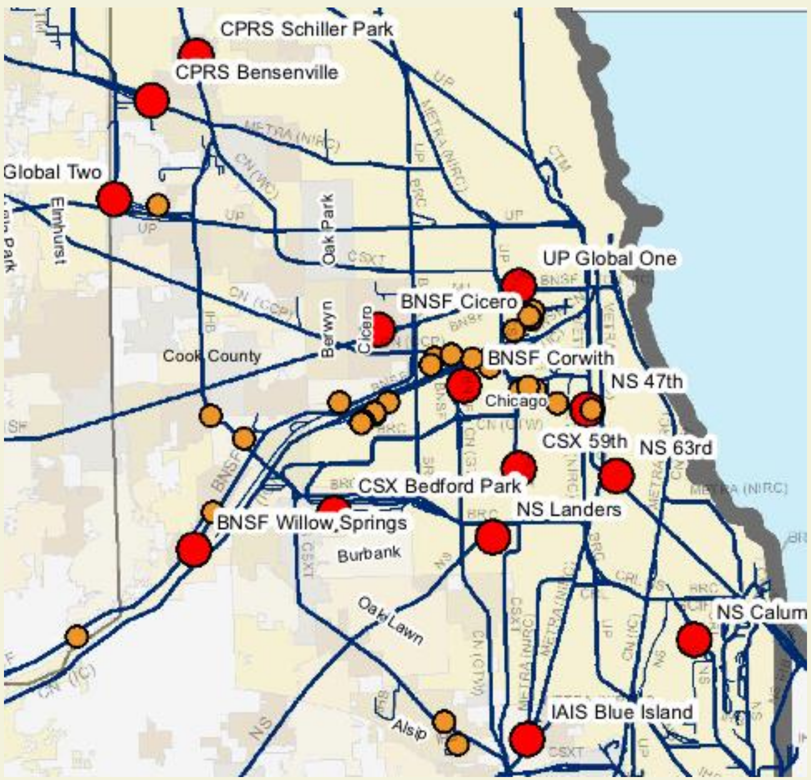


Chicago Area Expressways



Extensive railroad networks, high volume truck traffic

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Region One, Chicago Metro Area

1,422 Bridges

2,793 Miles of Highways

218 Interstate Miles

80 Million miles/day

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SMA is the mix of choice for the Chicagoland area expressways

- Mainline pavement as an overlay
- On bridge decks as an overlay
- Superb performance as a full depth HMA pavement

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SO WHY **SMA** ?

STRONG

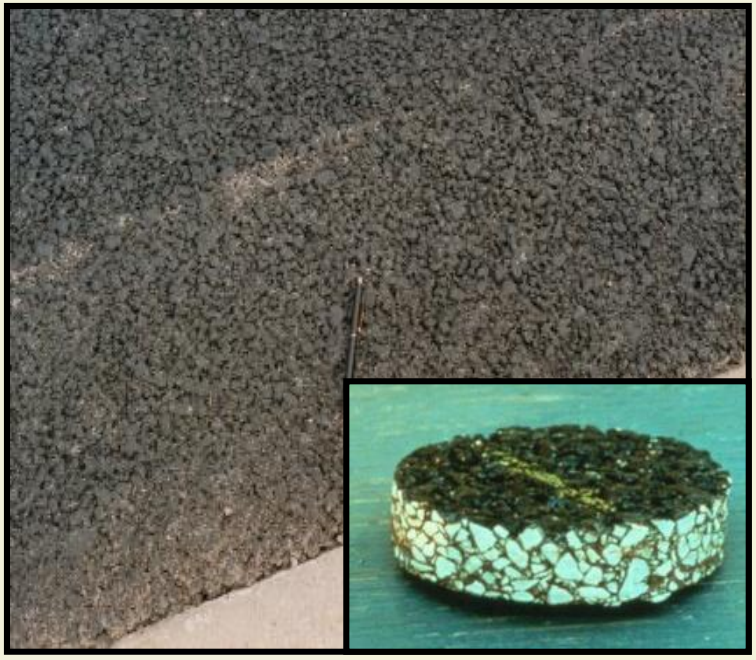
Stone on Stone Contact

DURABLE

Rich in Mortar Binder

COST EFFECTIVE

Longer Service Life



AASHTO-M325, 2008.

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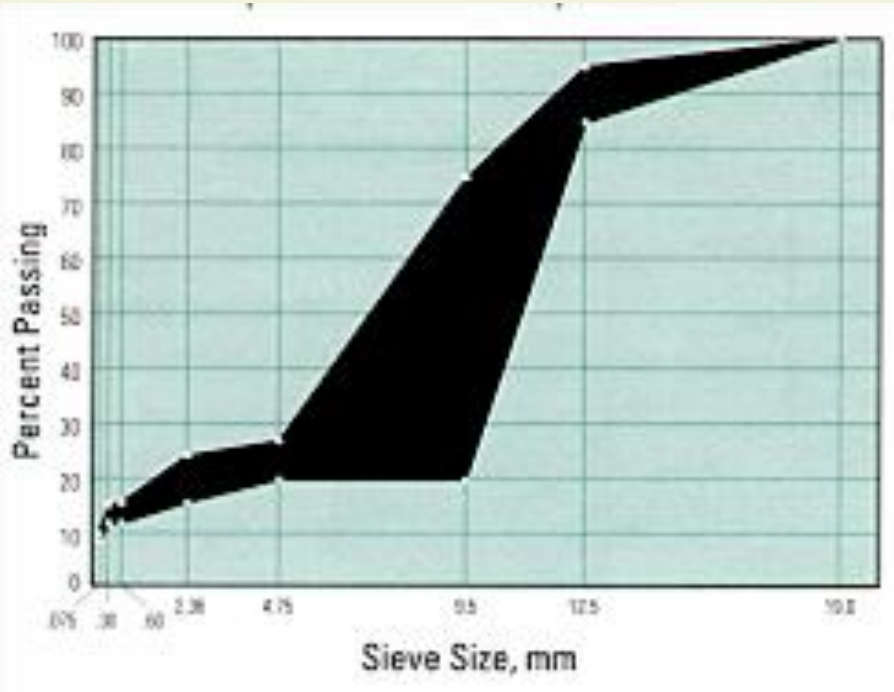
Started with a 12.5 mm Mix



AASHTO-M325, 2008.

SIEVE	***Limits % PASSING***
19MM	100
12.5MM	90-100
9.5MM	75 MAX
4.75MM	20-28
2.36MM	16-24
600mM	12-16
300mM	12-15
75mM	8-10

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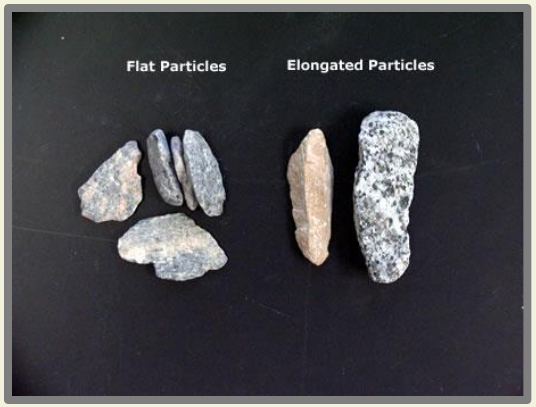
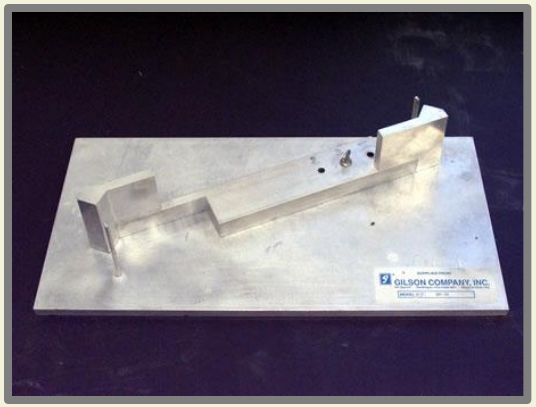
Aggregate

- FA
  - 100% Manufactured sand
  - FAA (method A) 45 MIN
  - Soundness loss 15 %MAX
  - Absorption 2 % MAX
- CA
  - LA abrasion 30 %MAX
  - Soundness loss 15 % MAX
  - F&E
    - 3 TO 1 20 % MAX
    - 5 TO 1 5 % MAX
  - Absorption 2 % MAX





ITP 4791

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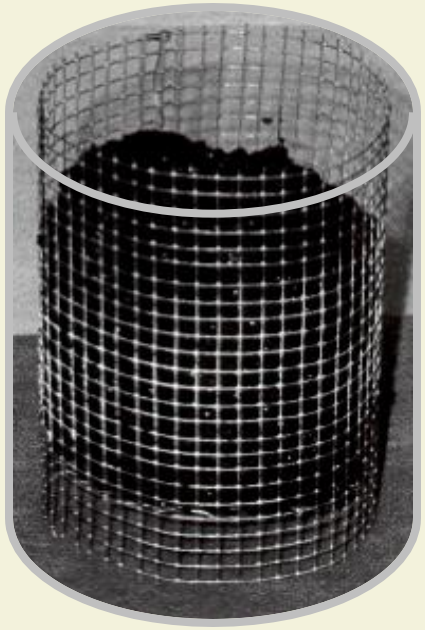
Design criteria:

• N_{des}	80 Gyrations
• Poly AC	6.0 % Typical Content
• VMA	17 % Min
• VTM	3.5%
• In-Pace Density	94% of MTD
• HW	6 mm Max 20 K Passes
• DRAIN DOWN	0.3 % MAX



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Other mix requirements:

ASPHALT CEMENT

- Polymer Asphalt Cement — SBS/SBR PG76-28
- Mixing Production Temperature — 325 – 325 F (150 C -160 C)

MINERAL FILER

- Mineral filler shall be free from organic impurities and have a PI ≤ 4

STABILIZER ADDITIVE

- CELLULOSE @ 0.3% OF MIX WEIGHT
- MINERAL FIBER @ 0.4 % OF MIX WEIGHT

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Critical to an SMA mix design:

- Voids in the Coarse Aggregates (VCA) is the volume between the coarse aggregate particles. VCA (DRC)
- The VCA of the CA fraction is determined by compacting the stone with the dry rodded technique according to T19.
- The SMA mixture must have a coarse aggregate skeleton with stone-on-stone contact. VCA (MIX)

Photo courtesy of Karol Kowalski and Adam Rudy
Purdue University, Via Web Search

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Critical to an SMA mix design:

$$VCA_{(MIX)} < VCA_{(DRC)}$$

However…

$$VCA_{(MIX)} > VCA_{(DRC)},$$

- An adjustment to the aggregate blend is in order, and
- Accomplished by an increase in the coarse aggregate fraction of the aggregate blend

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A typical Structural Overlay for an interstate is 4.75” to 5.0” (120 mm to 127 mm):

A 2” (50 mm) inlay has also been placed.

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- *Keeps the paver stops at a minimum*
- *Keeps mat temperature uniform*
- *Uniform mat temp will improve mat density*

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- Paving pace should be slow & consistent
- Ensure that the placemen hourly rate is slightly less than production rate
- Don’t out-run the breakdown rollers
- Slow paver down, but NEVER stop
- Maintain multiple trucks at the MTD

Night-time Paving or off peak hours, is very common and often times required

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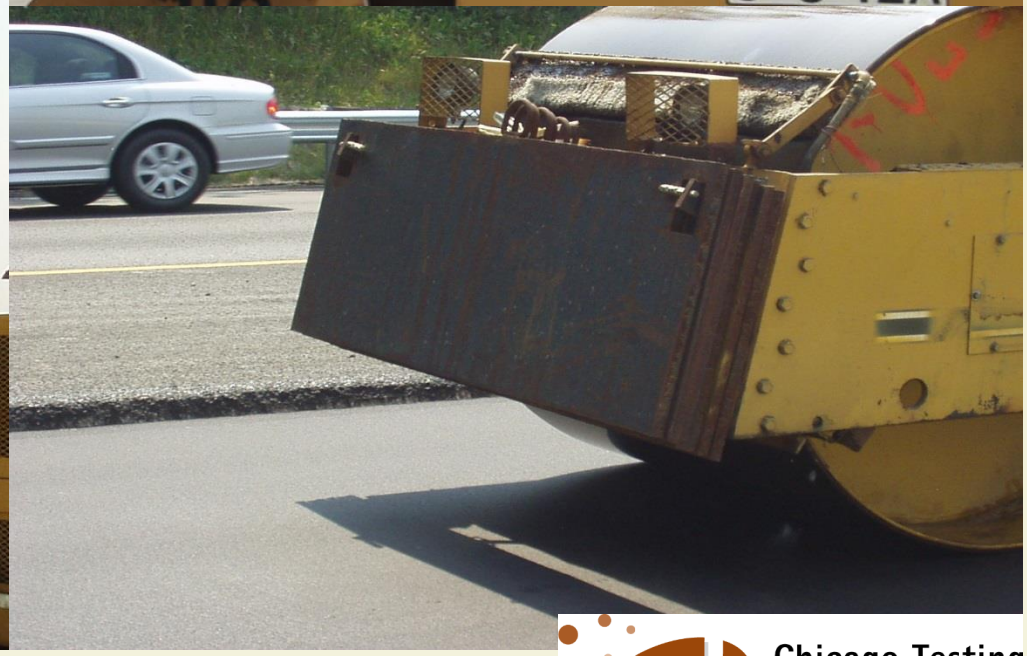
Properly Ballast Rollers

Should maintain a close rolling distance to the paver



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Early on, steel plates used as additional weight

Later on, 3 wheel static rollers, regained wider use to help productivity

Chicago Testing Laboratory, Inc.

Later on, 3 wheel static rollers regained wider use to help productivity

Chicago Testing Laboratory, Inc.

Design criteria:

• N_{des}	80 Gyrations
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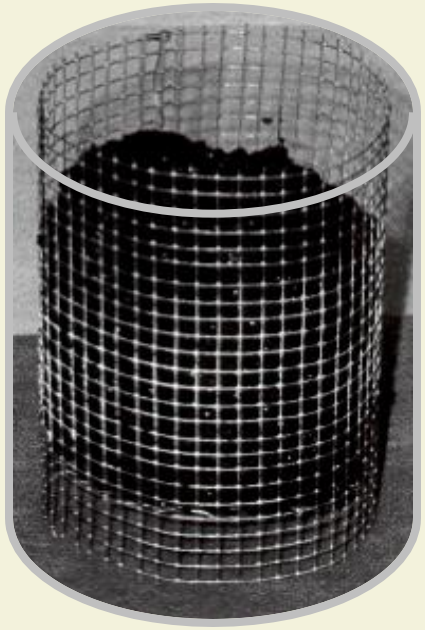

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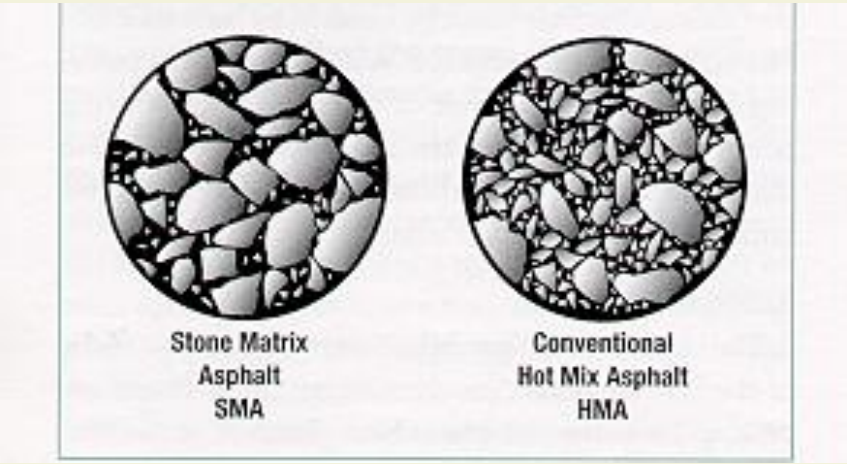
Hamburg Wheel data for SMA and dense graded mixes



Mixture Type	*# of Samples*	*Average Center Lane Density*	*Center Lane Rut 20,000 Passes*	*Average Wheel Lane Density*	*Wheel Lane Rut 20,000 Passes*
SMA	12	94.5%	3.5	94.4%	3.7
N-70	14	94.4%	8.9	94.7%	8.2

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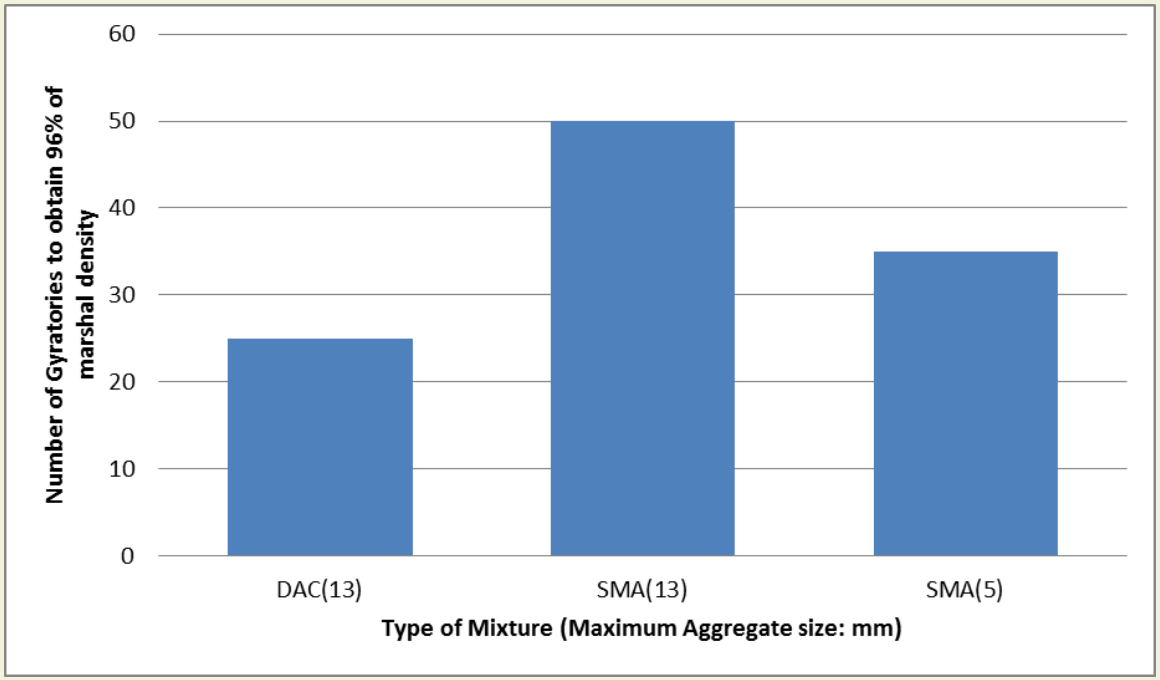
A laboratory test results using a gyratory compactor is shown in the figure below.

The dense asphalt concrete mixture (DAC13), required 25 gyrations to obtain 96 % of designed MTD density, while an SMA 13 required 50 gyrations.

The lab results indicated that twice the compaction energy is necessary for the SMA compaction compared to ordinary dense asphalt mixture.



Fujita, et al. 17th AAPA International Flexible Pavements Conference 2017

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Field compaction of SMA mix in Japan using a VTW & VPT Rollers:

The purpose was to compare the effect of the combination of the VTW roller and the VPT roller.

- The compacted layer thickness was 40 mm.
- There were three pavement sections.
- The same paver model was used a VOGEL super 2100.
- The VTW roller was used in the Break Down.
- The VPT roller was used in the intermediate position behind the VTW.
- The Vibratory tandem (VT) roller was used for finishing compaction as static roller (no vibration).

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Paver

VTW roller

VPT roller

Mix design data of the SMA mixture.

Sieve Size (mm)	%
19 mm	100
13.2 mm	99.8
4.75 mm	47.5
2.36 mm	32.8
600 um	24.1
300 um	16.8
150 um	12.7
75 um	10.6
Binder content (%)	6.4
Asphalt binder type（penetration）	60/80

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The rolling patterns used are shown in the table below:

- The breakdown roller for each section was a VTW roller in static mode in section 1.
- In the case of VTW roller sections, all passes of the VTW were made in oscillatory vibration mode.
- The second roller for each section was a VPT roller. Amplitude setting number 1 was used in section 1, amplitude setting 2 in section 2 and amplitude setting 4 in section 3.
- The finish roller for each section was the VT roller. All passes of this roller were static mode.
- Each roller traveled at 3 km/h and all the rollers compacted from cold side 200 mm (8 in) away from longitudinal joint.

Rolling Patterns and Percent of TMD

Section No.	Rolling Process	Roller Type (Model)	Roller Mass (kg)	Operating Speed (km/h)	Number of Rolling Passes(pass)	Vibration Mode	Average Percent of TMD(%)
1	Breakdown	STW (MW700)	8730	3	8	Static	93.9
	Second	VPT (GE750)	9100	3	8	Vib.1st Amp.	
	Finsh	VT (SW650)	7100	3	8	Static	
2	Breakdown	VTW (MW700)	8730	3	8	Oscillation	94.7
	Second	VPT (GE750)	9100	3	8	Vib.2nd Amp.	
	Finsh	VT (SW650)	7100	3	8	Static	
3	Breakdown	VTW (MW700)	8730	3	8	Oscillation	95.3
	Second	VPT (GE750)	9100	3	8	Vib.4th Amp.	
	Finsh	VT (SW650)	7100	3	8	Static	

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11” of SMA was placed back in 1997 on this route which is the gate to a major quarry

Using SMA in full depth application

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New North Avenue Bridge over Chicago River

Designed for Latex Concrete Wearing Surface

Built in December 13, 2007 With SMA as a Wearing Surface


HYSTER


638
HYSTER

Overlays on existing structures

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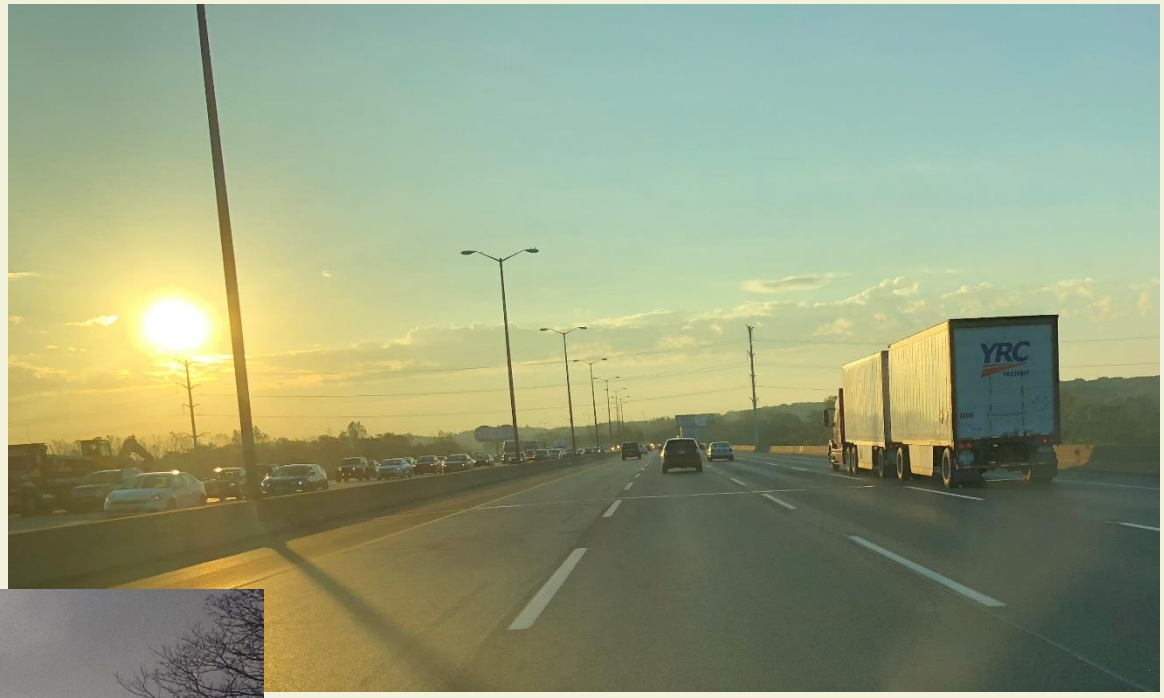
Overlays on existing structures



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For an improved bond of the overlay to the bridge deck surface, consider the following:

- Hydro scarification of the surface
- Heavier application rate of tack coat

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Inside view of multi- jet rotating blasting head
Recommended Water pressure
range
30 K to 35 K PSI

Surface texture achieved after Hydro scarification

Milled surface

Hydro scarified surface

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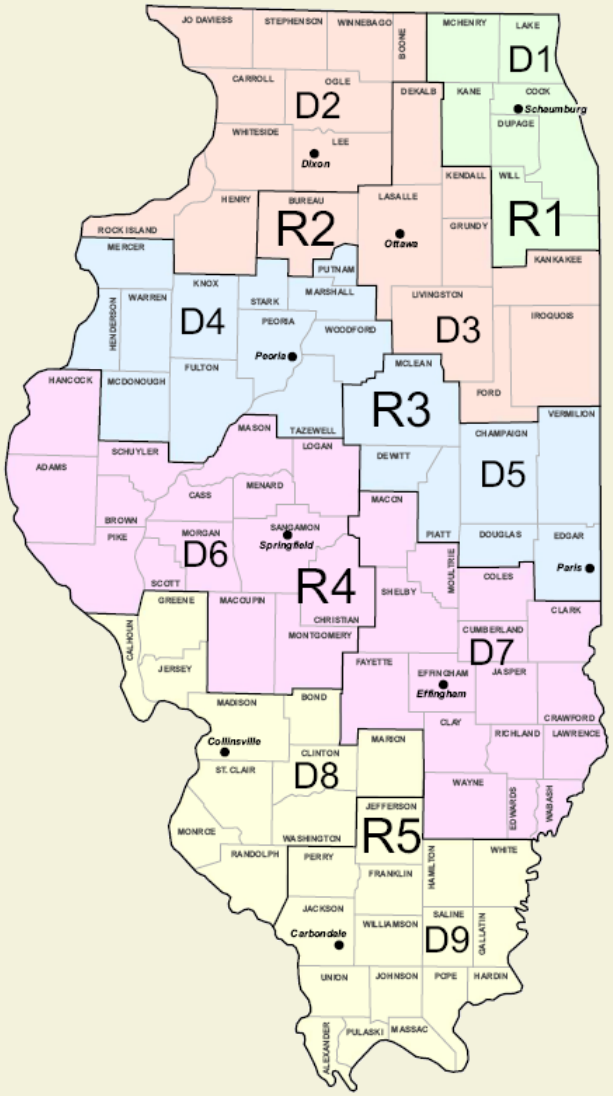

Statewide:

- Over 140,745 miles

IDOT:

- 16,000 miles of highways
- 7,741 bridges
- 2,182 miles of Interstate Routes

This is the 3rd largest in the Nation!!

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To Recap:

For the Chicago Metro Region

1,422 Bridges

2,793 Miles of Highways

218 Interstate Miles

80 Million miles/day

Chicago Testing Laboratory, Inc.

High volume interstate traffic

Heavy, concentrated loading

For the last 20+ years under the most demanding traffic conditions in the Chicagoland area, SMA has been the mix of choice.

With its stone-on stone-contact and asphalt rich mortar, an SMA mixture will provide the needed strength and durability to meet the challenges of heavy traffic conditions.

Chicago Testing Laboratory, Inc.

Questions?

Chicago Testing Laboratory, Inc.

Thank you

Questions

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