# True Performance of SMA Mixture: What's in your road?

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# SHOULDERS……The Tollway's Sandbox

# Tollway Innovations on Shoulders

- Terminal Blend Ground Tire Rubber (GTR) on XX in XXXX
- Recycled Asphalt Shingles (RAS) on I-39 in 2007
- Dry Process GTR on I-88 in 2015
- Rejuvenators on I-88 in 2018

# Strong Foundation with Recycle

- **Asphalt Binder Ratio (ABR) is tied to PG Grade**
- Use of softer binders with high ABR:
  - 0-20% ABR – PG XX-22
  - 21 - 30% ABR – PG XX-28
  - 31 – 50% ABR – PG XX-34
- Contractor's choice to use FRAP or RAS
  - No non-fractionated RAP is allowed in SMA mixes

# A little history of Rubber …


- Extensively studied in the late 1990's
- Spent the next few decades improving the grinding process – making it FINER
- ASTM D6114-09
  - Blends vulcanized rubber with AC @15%
  - Specific gradation

# Terminal GTR vs Dry Process GTR

## Terminal Blend

- #30-#100
- Heated and blended in the terminal at 330°F - 400°F
- Considered a “Modifier”

## Dry Process

- Also #30 minus
- Metered into the RAP collar at the HMA plant
- Considered an “Additive”

# Ground Tire Rubbers and SBS

- **We treat them all the same.**
- Contractor's choice to use any of the following:
  - SBS Polymer
  - Terminal GTR
  - Dry Process GTR
  - Hybrid GTR

***2018 I-88 SMA Bid Documents:***

| Reclaimed Material | Asphalt Binder Replacement, % | Asphalt Binder Options |
|---|---|---|
| **Category 1 or 2[1] FRAP only or with RAS** | Less than 20 | SBS/SBR PG 76-22<br>GTR PG 76-22<br>PG 64-22 10% Dry GTR |
| | 21 to 30 | SBS/SBR PG 70-28<br>GTR PG 70-28<br>PG 58-28 10% Dry GTR |
| **Category 1 FRAP** | 31- 50 | SBS/SBR PG 64-34<br>GTR PG 64-34<br>PG 52-34[2] 10% Dry GTR |

# Who doesn’t love options?

# N80 IL 12.5 REC SMA - ABR

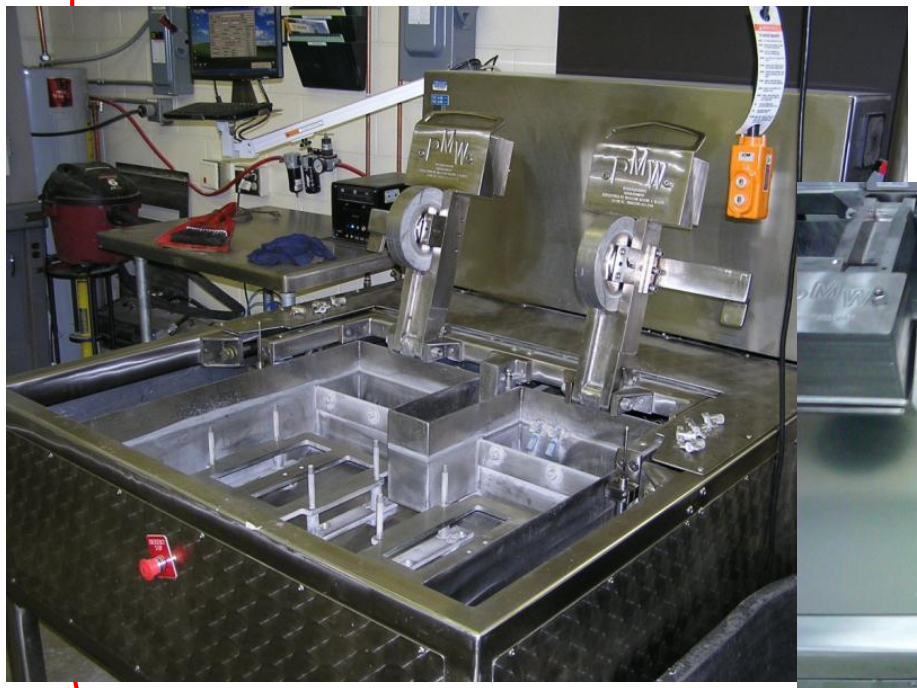
| Contractor | Tollway Mix # | Mixture Description | FRAP | RAS | Total AC | ABR |
|---|---|---|---|---|---|---|
| Plote | 90WMA 1841 | BINDER | 29.0% | 5.0% | 6.3 | 50.1 |
| Curran | 90WMA 1833 | SURFACE | 19.0% | 4.0% | 6.0 | 37.1 |
| Geneva | 90WMA 1839 | FRICTION SURFACE | 24.5% | 2.4% | 6.0 | 25.8 |
| Rock Road | 90WMA 1824 | FRICTION SURFACE | 20.0% | 4.0% | 6.1 | 37.6 |

# N80 IL 12.5 REC SMA – AC Modifier

| Contractor | Tollway Mix # | Mixture Description | ABR | WMA | GTR |
|---|---|---|---|---|---|
| Plote | 90WMA 1841 | BINDER | 50.1 | 0.4% | PG 46-34 +10% ECR (Dry Process) |
| Curran | 90WMA 1833 | SURFACE | 37.1 | 0.4% | PG 46-34 +10% ECR (Dry Process) |
| Geneva | 90WMA 1839 | FRICTION SURFACE | 25.8 | 0.4% | PG 58-28 +12 GTR (Terminal) |
| Rock Road | 90WMA 1824 | FRICTION SURFACE | 37.6 | 0.4% | SBS PG 64-34 |

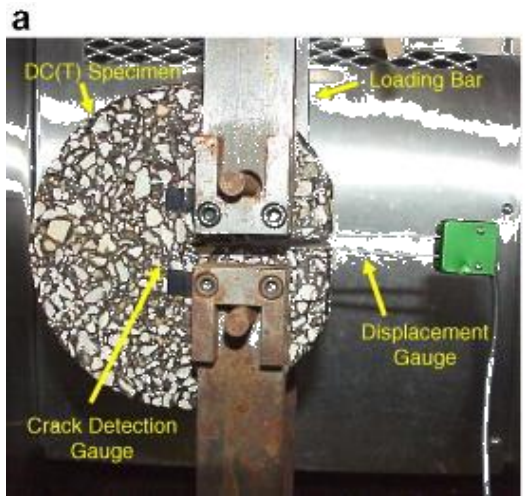
# Practical Performance Testing

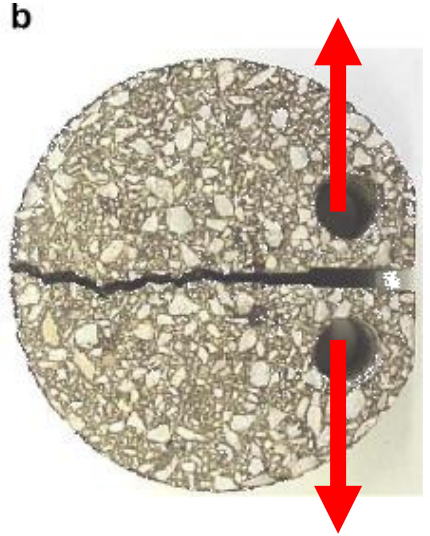
## Is it going to Rut or Strip?



**Hamburg (AASHTO T-324)**

## Is it going to Crack?




**Direct Compact Tension (DCT) (ASTM D 7313)**

# Performance Testing Criteria

- Hamburg Criteria

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

- DCT Criteria

| 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 | GTR | 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 |

# Let's talk about binder grading

**AC from Recycled Material is Harder - This is not a new concept:**

Table 3.4 Effect of Percentage of RAP

| Virgin Binder Added | % RAP Added | Effective PG Grade | |
|---|---|---|---|
| 58-34 | 15% | 63.0 | -32.7 |
| 58-34 | 25% | 65.7 | -32.0 |
| 64-28 | 15% | 66.9 | -27.9 |
| 64-28 | 25% | 71.0 | -26.5 |

*Determination of the PG Binder Grade to Use in a RAP Mix – Project 99-1, 2001*

# 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 <u>Recovered Binders:</u>

| | |
|---|---|
| Shoulders | PG 64-22 |
| Mainline | PG 70-22 |
| High Volume | PG 76-22 |

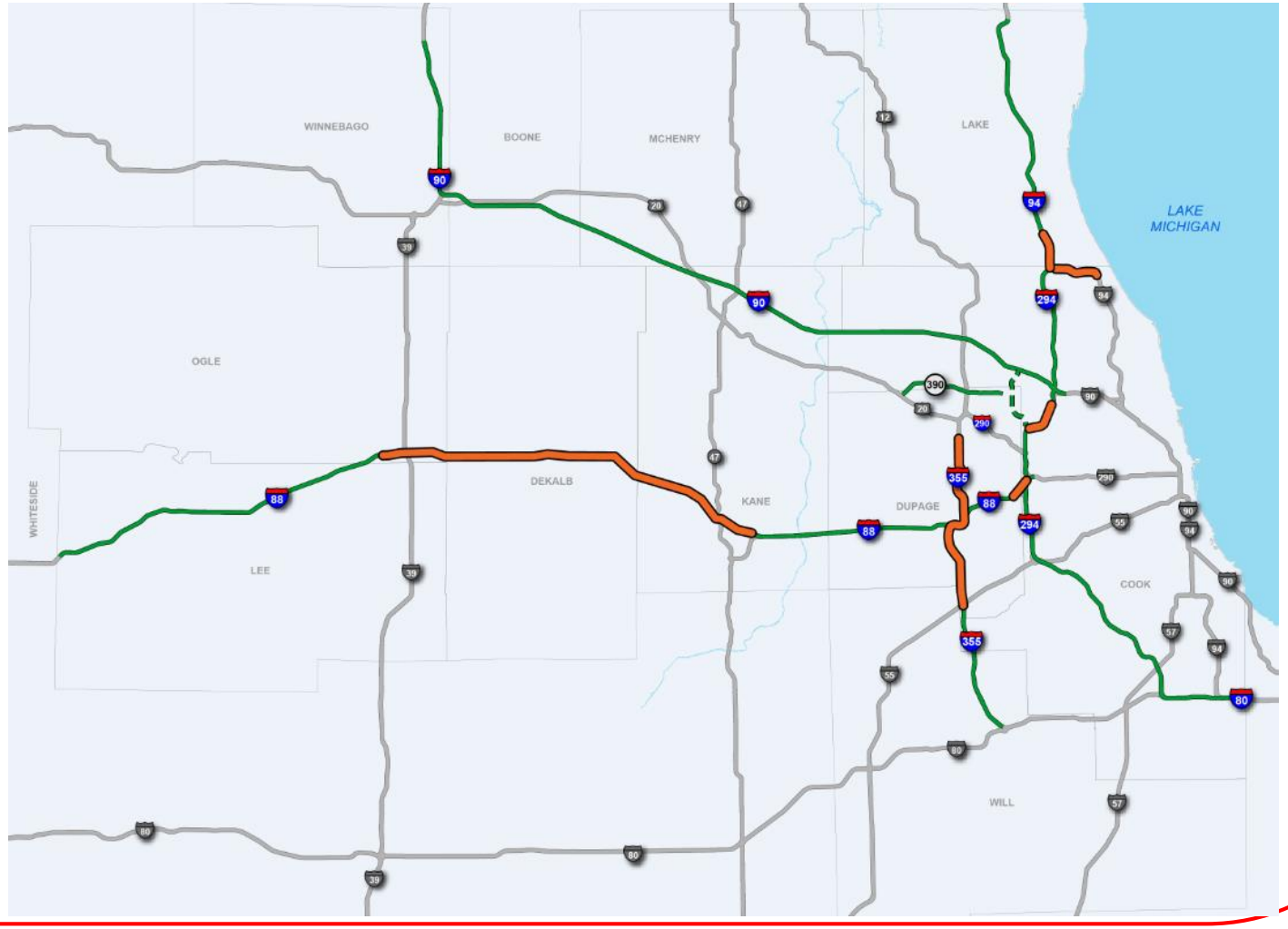

**What's the real PG in the road?**

# N80 IL 12.5 REC SMA – Recovered Grading

| Contractor | Tollway Mix # | Mixture Description | ABR | GTR | 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) | Not available by presentation time |
| 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 |

# Tollway contracts

- I-88 IL 251 to IL 56
- I-355 Army Trail to I-55
- Mary-Nora ramps
- Eden's Spur
- I-94 Eden's Spur to Half Day Rd.
- I-294 Wolf Road to Bal Moral



# Let's look at the numbers….

| 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) | 20,209 | $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** | |

*some construction is still on-going

# Remember our Sand Box? Rejuvenators Baby!!

| 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 |
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| 9 | 9 | Full-Depth WMA Lane Pavement | 13,126 | $74.18 |
| | | | **912,625** | |

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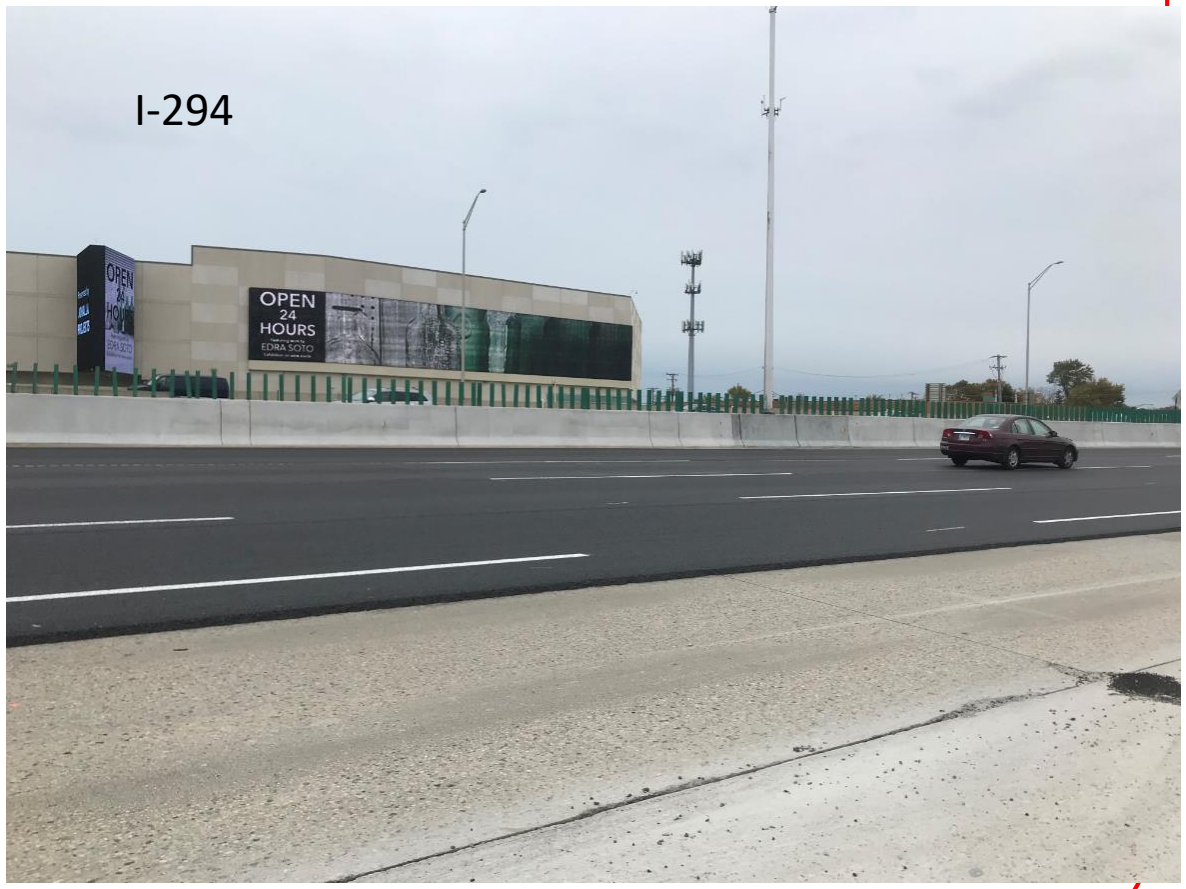
# A picture is worth a thousand words…

# A picture is worth a thousand words…


# This wouldn't have happened without contractor/supplier cooperation:











# SMA – not only for roadways anymore….

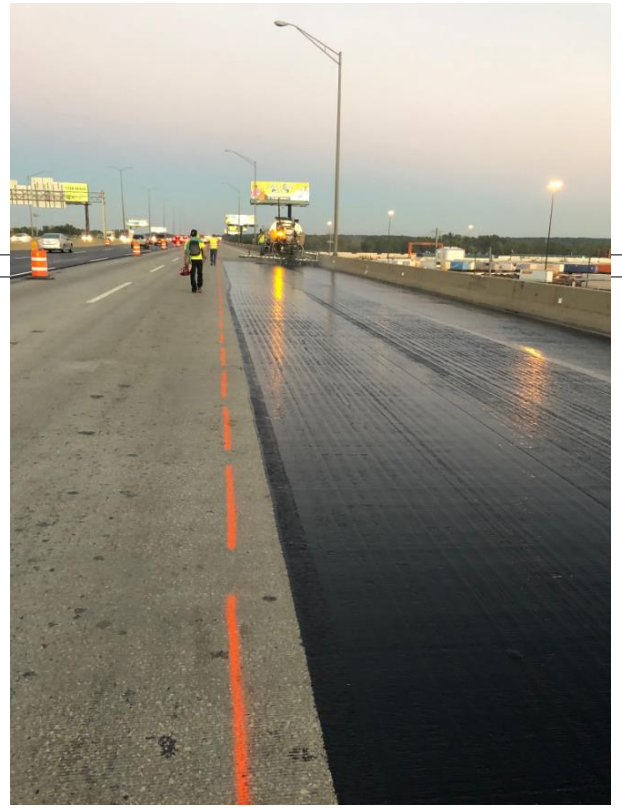
# The Mile Long Bridge…. literally.

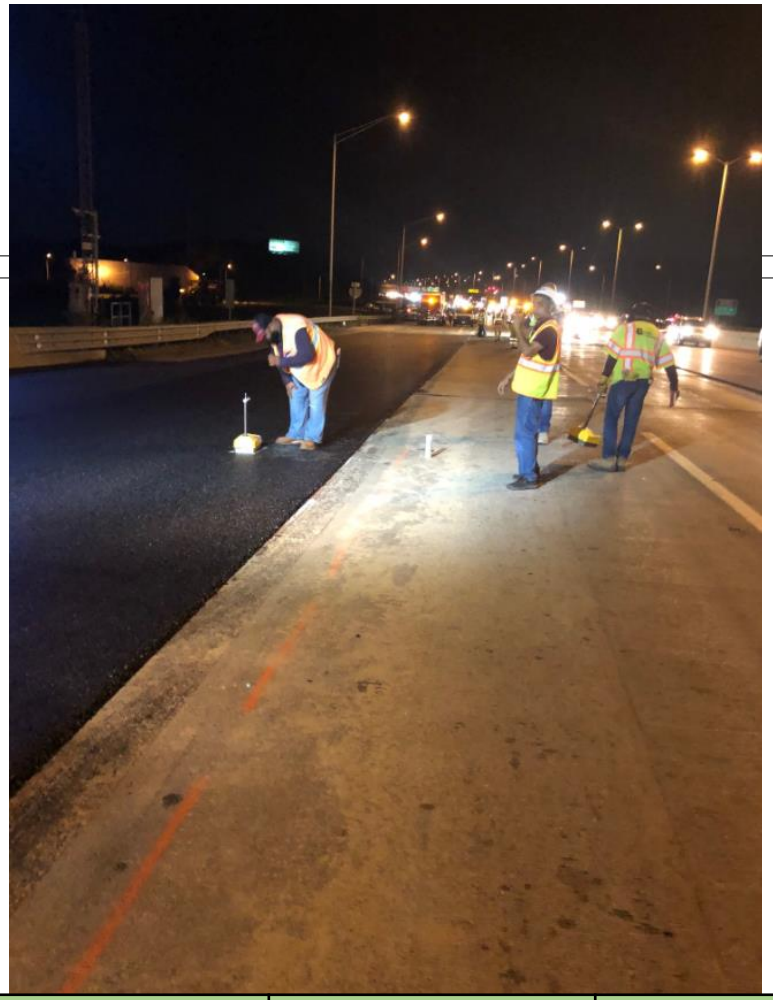
**<u>Laundry list</u>** ***(also a mile long):***

- Overlay cannot be over 25 lbs/sf
- The patches are of all material types
- Have to keep 2 lanes of traffic open at one time
- Has 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





| Contractor | Tollway Mix # | Mixture Description | ABR | AC | DCT | Hamburg |
|---|---|---|---|---|---|---|
| K-5 | 90WMA453K | FRICTION SURFACE | 19.9 (11% FRAP 2.8% RAS) | SBS 70-28 | 904 J/m$^2$ | -3.69mm @20,000 |

# Now onto the Northbound??

- Changes for Northbound overlay based on lessons learned:
  - Start with Tack Coat (will adhere to the patches)
  - Pave with a 4.75mm sand mix (create a platform for the LJS and SMA)
  - Place the LJS (seal the deck)
  - Then come back with the SMA (wearing friction surface)
- Concerns:
  - Same lane closure constraints
  - Will there be enough time to pave multiple lifts?
  - And lastly….

# It all starts with leadership…

# Work Hard, Play Hard!