Optimized or Balanced Mix Design

- Crack Resistant
- Rut Resistant
- Resistant to Moisture Damage
Balanced Mix Design: ETG Definition

- Asphalt mix design using *performance tests* on appropriately *conditioned specimens* that address *multiple modes of distress* taking into consideration mix aging, traffic, climate and location within the pavement structure.

Performance Pendulum (Shane Buchanan, Oldcastle)
Disk-Shaped Compact Tension (DCT) Test

- ASTM D7313-13
- Loading Rate:
  - Crack Mouth Opening Displacement
  - CMOD Rate = 1.0 mm/min
- Measurements:
  - CMOD
  - Load
Semi-Circular Bend (SCB) Test

- Multiple variants exist
  - Early work in Europe
  - Simultaneous cold (Marasteanu et al. – MN) and intermediate temperature (Mohamed et al. – LA) versions
  - Recent work from Al-Qadi et al. (IL) $\rightarrow$ AASHTO TP 105

- AASHTO TP 105 (I-FIT)
  - Line load control, loading rate = 50 mm/min
  - Test temperature = 25 deg. C

- Measurements:
  - Displacement
  - Load

- Outcomes
  - Fracture Energy
  - Flexibility Index (FI)
Fracture Parameters

Fracture work: Area under Load-Displacement curve

Fracture Energy, $G_f$: Energy required to create unit fracture surface

$G_f = \frac{\text{Fracture Work, } S_f}{\text{Fracture Area}}$

Flexibility Index, FI:

$FI = \frac{G_f}{m}$
DISTRICT 11 WINTER SCHOOL
Crown Plaza, Greentree  Feb., 1, 2017

PA Asphalt Pavement Association
Gary L Hoffman, P.E.
Director of Technical Services
Agenda

1. Who we are!
2. PAPA Mission and Goals
3. PWT Implementation- LTS & HOLA
4. Warm Mix Require
5. Anti-Strip Additive
6. Long Life Asphalt Pavements
7. Performance Testing for Mix Optimization
8. Higher RAP/ RAS Mixes
9. Thinlay Special Provision
10. Porous Asphalt Specification
12. Upcoming PAPA events you may want to attend
Who we are!

1. Charles Goodhart - Executive Director
cgoodhart@pa-asphalt.org
2. Gary Hoffman - Director of Technical Services
gary@pa-asphalt.org
3. Tina Holtzman - Office Administrator
tina@pa-asphalt.org
millie@pa-asphalt.org
PA Asphalt Pavement Association Mission

• “To promote and provide to our customers the best available asphalt pavement technology and to represent and serve the common interests of our members.”

• Goals:
  ▫ **Maintain Cooperative Relationships and Communications**
  ▫ **Ensure Best Quality Products and Pavements**
  ▫ **Support Government Affairs and Strategic Alliances**
  ▫ **Promote and Market Asphalt Pavements**
  ▫ **Promote Innovation and Environmental Awareness**
  ▫ **Ensure Association Viability**
Percent Within Tolerance
WHAT’s PWT?

- Efficiently captures mean and standard deviation in one quality measure

\[
\overline{X} - \text{mean} \\
\text{s} - \text{standard}
\]

\[
\begin{array}{cccccc}
-3s & -2s & -1s & 1s & 2s & 3s \\
\end{array}
\]
Standard Deviation

- 68% within 1 standard deviation (1σ)
- 95% within 2 standard deviations (2σ)
- 99.7% within 3 standard deviations (3σ)
PWT - Think of a Field Goal Kicker
What Does PWT Drive?

- Drives more consistency in materials and construction

- Tighter adherence to producing job mix formula

- Tighter adherence to field density specification requirements
Advantages of PWT

• Well suited for low bids to achieve higher quality
• Contractors = **bonuses** for tighter adherence to targets
• Contractors = **reduced payments** for lesser consistency
• Moves focus to targets (NOT minimums)
What’s different with PWT spec?

• Adds **bonus** structure (maximum 4%)

• Adds **mix gradation** (PCS) as part of payment

• Modifies current “goal posts” approach for 100% payment (good or no good) to a more probabilistic and statistical approach
Payment Equation Changes

- **Current** specification (50% mix, 50% density)
  - 25% asphalt content
  - 25% #200 sieve
  - 50% field density

- **PWT** specification (50% mix, 50% density)
  - 30% asphalt content
  - 10% #200 sieve
  - 10% primary control sieve (new)
  - 50% field density
Common to All PWT Specs

• **Defective lots** can be left in place at 70% pay by DE (previously 50% pay)

• **Allows contractor to terminate lot**
  - Allows contractor to limit risk when early QC results indicate an issue
  - Must stop paving
  - 90% maximum pay
  - Must R&R if defective by test results
Current Status

Two (2) methods:

1. **PWT-LTS (Laboratory Testing Section)**
   1. Fully approved (includes FHWA)
   2. Acceptance at LTS
   3. PWT-LTS Use Guidelines/District Memo

2. **PWT-HOLA (Hands On Local Acceptance)**
   1. Fully approved (includes FHWA)
   2. Department Acceptance, Contractor Lab
# 2016 PWT Summary

158 PWT Projects Let in 2016

<table>
<thead>
<tr>
<th>District</th>
<th>Total Active Project</th>
<th>SSP included in Advertisement</th>
<th>SSP Used on Project</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>LTS</td>
<td>HOL A</td>
</tr>
<tr>
<td>1-0</td>
<td>9</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>2-0</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3-0</td>
<td>8</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>4-0</td>
<td>3</td>
<td>3</td>
<td>0</td>
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<tr>
<td>5-0</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6-0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>8-0</td>
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<td>1</td>
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<tr>
<td>9-0</td>
<td>12</td>
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<td>7</td>
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<tr>
<td>10-0</td>
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<td>5</td>
<td>1</td>
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<tr>
<td>11-0</td>
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<td>12-0</td>
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<tr>
<td>Total</td>
<td>86</td>
<td>73</td>
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### Industry Breakdown of Active Projects

<table>
<thead>
<tr>
<th>Prime Contractors (ea.)</th>
<th>Suppliers (Plants) (ea.)</th>
<th>Paving Contractors (ea.)</th>
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<tbody>
<tr>
<td>32</td>
<td>57</td>
<td>31</td>
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## 2016 PWT Summary
### (As of January 6, 2017)

### Overall Lot Payment Averages

<table>
<thead>
<tr>
<th>Lots</th>
<th>Average Lot Payment</th>
<th>Average Lot Payment (Cores)</th>
<th>Average Lot Payment (Other)</th>
<th>Asphalt Content</th>
<th>#200 Sieve</th>
<th>Primary Control Sieve</th>
<th>Density (Cores/Optimum Rolling/Non-Movement)</th>
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<tbody>
<tr>
<td>Total</td>
<td>452</td>
<td>1.01</td>
<td>1.02</td>
<td>1.01</td>
<td>101.27</td>
<td>101.12</td>
<td>100.25</td>
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<tr>
<td>PWT-HOLA</td>
<td>121</td>
<td>1.02</td>
<td>1.02</td>
<td>1.01</td>
<td>102.26</td>
<td>101.98</td>
<td>101.03</td>
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<td>PWT-LTS</td>
<td>331</td>
<td>1.01</td>
<td>1.01</td>
<td>1.00</td>
<td>100.89</td>
<td>100.80</td>
<td>99.95</td>
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### Average Density Pay Factor (Cores Only)

<table>
<thead>
<tr>
<th>Total</th>
<th>HOLA</th>
<th>LTS</th>
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<tbody>
<tr>
<td>Lots</td>
<td>Pay Factor</td>
<td>Lots</td>
</tr>
<tr>
<td>Total</td>
<td>355</td>
<td>102.03</td>
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<tr>
<td>BPN 1</td>
<td>2</td>
<td>103.00</td>
</tr>
<tr>
<td>BPN 2</td>
<td>139</td>
<td>101.82</td>
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<tr>
<td>BPN 3</td>
<td>168</td>
<td>102.21</td>
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<tr>
<td>BPN 4</td>
<td>46</td>
<td>102.60</td>
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## 2016 PWT Summary
(As of January 6, 2017)

<table>
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<tr>
<th></th>
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<th>Sec. 409</th>
<th>PWT-HOLA</th>
<th>PWT-LTS</th>
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<tbody>
<tr>
<td>Bonus Pay Lots</td>
<td>336</td>
<td>N/A</td>
<td>101</td>
<td>235</td>
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<tr>
<td>100% Pay Lots</td>
<td>30</td>
<td>420</td>
<td>8</td>
<td>22</td>
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<td>Reduced Pay Lots</td>
<td>80</td>
<td>21</td>
<td>12</td>
<td>68</td>
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<tr>
<td>Defective Lots</td>
<td>6</td>
<td>11</td>
<td>0</td>
<td>6</td>
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<tr>
<td>Terminated Lots</td>
<td>0</td>
<td>N/A</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>452</td>
<td></td>
<td>121</td>
<td>331</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>District</th>
<th>Incentives</th>
<th>Reductions</th>
<th>Δ</th>
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<tbody>
<tr>
<td>1</td>
<td>$163,333.05</td>
<td>-$55,637.69</td>
<td>$107,695.36</td>
</tr>
<tr>
<td>2</td>
<td>$46,908.89</td>
<td>-$18,866.20</td>
<td>$28,042.69</td>
</tr>
<tr>
<td>3</td>
<td>$66,837.57</td>
<td>-$18,450.16</td>
<td>$48,387.41</td>
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<tr>
<td>4</td>
<td>$83,430.09</td>
<td>$0.00</td>
<td>$83,430.09</td>
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<td>5</td>
<td>$88,680.57</td>
<td>-$20,140.30</td>
<td>$68,540.27</td>
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<tr>
<td>6</td>
<td>$0.00</td>
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<tr>
<td>8</td>
<td>$213,800.95</td>
<td>-$244,046.31</td>
<td>-$30,245.36</td>
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<tr>
<td>9</td>
<td>$104,490.10</td>
<td>-$45,848.47</td>
<td>$58,641.63</td>
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<tr>
<td>10</td>
<td>$156,313.92</td>
<td>-$4,871.88</td>
<td>$151,442.04</td>
</tr>
<tr>
<td>11</td>
<td>$144,013.41</td>
<td>-$20,736.51</td>
<td>$123,276.90</td>
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<td>12</td>
<td>$100,296.68</td>
<td>-$26,007.13</td>
<td>$74,289.55</td>
</tr>
<tr>
<td>Total</td>
<td>$1,168,105.23</td>
<td>-$454,604.65</td>
<td>$713,500.58</td>
</tr>
</tbody>
</table>
2016 PWT Summary
(As of January 6, 2017)

80 Reduced Pay Lots

- AC/Density/Gradation - 4 ea.
- Density/Gradation - 11 ea.
- AC/Density - 3 ea.
- Gradation - 11 ea.
- AC - 19 ea.
- AC/Gradation - 18 ea.

6 Defective Lots

- AC - 3 ea.
- Density - 3 ea.
2016 PWT Summary
(Data from January 1, 2015 – November 23, 2016)

(Sublot Acceptance Test Results for 9.5mm, 12.5mm, 19mm & 25mm Mixes, excludes SMA)
2016 PWT Summary
(Data from January 1, 2015 – November 23, 2016)

(Lot Acceptance Test Results for 9.5mm, 12.5mm, 19mm & 25mm Mixes, excludes SMA)
PWT - Any Questions?

- What about municipal projects?
- What type of paving projects (base, pavement design, shoulders, etc.)?
Warm Mix Asphalt
What's **WMA**?

- **Definition of Warm Mix Asphalt** - Warm Mix Asphalt (WMA) is the generic term for a variety of technologies that allow producers of Hot Mix Asphalt (HMA) pavement material to lower temperatures at which the material is mixed and placed on the road. It is a proven technology that improves the “lubricity” of the binder.

411.2 MATERIAL - Section 409.3 with additions and modifications as follows

Table A
Job-Mix Formula
Composition Tolerance Requirements of the Completed Mix
Section 409.2(e), Table A. Revise the Temperature of Mixture (F) requirements as follows:

<table>
<thead>
<tr>
<th>Class of Material</th>
<th>Type of Material</th>
<th>Minimum*</th>
<th>Maximum*</th>
</tr>
</thead>
<tbody>
<tr>
<td>PG 58-28</td>
<td>Asphalt Cement</td>
<td>215</td>
<td>310</td>
</tr>
<tr>
<td>PG 64-22</td>
<td>Asphalt Cement</td>
<td>220</td>
<td>320</td>
</tr>
<tr>
<td>PG 76-22</td>
<td>Asphalt Cement</td>
<td>240</td>
<td>330</td>
</tr>
<tr>
<td>All other Binders</td>
<td>Asphalt Cement</td>
<td>The higher of 215 or the minimum temperature specified in Bulletin 25 minus 45</td>
<td>As specified in Bulletin 25</td>
</tr>
</tbody>
</table>
411.2 MATERIAL - Section 409.3 with additions and modifications as follows

Table A
*The minimum and maximum temperatures shown in Table A for each Class of Material represent the master temperature range for a completed WMA mixture. The Producer must include a smaller production temperature range that does not exceed 50F and does not fall outside the master temperature range in the Producer QC Plan for normal paving.
Benefits of WMA

Benefits of Warm Mix Asphalt –

- Improves asphalt mix compaction density
- Improves consistency of asphalt coating
- Extends the paving season
- Allows asphalt mix to be hauled longer distances
- Improves working conditions by reducing exposure to fuel emissions, fumes, and odors

http://www.fhwa.dot.gov/innovation/everydaycounts/edc-1/wma.cfm
WMA Implementation by PennDOT

- 2014 – 9 of 11 Engineering Districts WMA
- 2015 – 10 of 11 Engineering Districts WMA
- 2016 – 11 of 11 Engineering Districts WMA
- 2017 – 100% WMA
Anti-Strip Additive - WMA & HMA

**Asphalt Stripping:**
The loss of bond between aggregates and asphalt binder that typically begins at the bottom of the HMA layer and progresses upward. When stripping begins at the surface and progresses downward it is usually called **raveling**.
Need for Anti-Strip Additive

“Cost Benefit Analysis of Anti-Strip Additives in Hot Mix Asphalt with Various Aggregates”

FINAL REPORT
May 15, 2015

Donald Christensen
Advanced Asphalt Technologies, LLC

Dennis Morian
William Wang
Quality Engineering Solutions, Inc.
Anti-Strip Additive

• What is an AS Additive?
• Concerns:
  ➢ TSR Testing
  ➢ AS Approval List (What about Evotherm?)
  ➢ Basis for quantity of AS Additive
  ➢ CT S-16-001 Step 2 - Revises Pub. 408-Sect. 411, 311, POM-Sect. C04-02, C04-03, Pub 242-Ch5, Bulletin 27-Chapters 2A & 2B
  ➢ Implement 2017
Need for Anti-Strip Additive

2017- Put at least .25% AS in all mixes
Long Life Asphalt Pavements
Longer Life Asphalt Pavements


- Limited initially to Interstate Highways & Look-a-Likes
- Totally new requirement will be Performance Testing for Crack Resistance and Rutting.
- Eventually incorporate into PUB 408 & other Publications
TQI - LLAP Specification Work Group Schedule

- PennDOT, PTC, FHWA, Industry Coordination Meeting – October 2015
- LLAP Spec Draft for APQIC – January 2016 (Completed)
- CT Step 1 for Review – April 2016 (Completed)
- CT Step 2 for Review – June 2016
- Request Candidate Pilot Projects (2017 Construction Season) – November 2016
LLAP - To get the initiative moving, the team assembled a large list of Best Practices. These Best Practices are incorporated into a series of Standard Special Provisions which were approved. SOL was sent to the Districts requesting pilot projects. Three projects have been submitted to date.
Long - Life Asphalt Pavements (LLAP) Pavement Design

• Use Guidelines

• PavementME (April Training)

• Perpetual Pavement Design

• Limiting Strain Design
Long - Life Asphalt Pavements (LLAP)

Asphalt Mix Design

- Minimum Effective AC Content \( (P_{be}) \)
- SuperPave Design Volumetric Adjustments
- Binder Modification (i.e. polymer, GTR, Fiber, etc.)
Long - Life Asphalt Pavements (LLAP)
Asphalt Mix Design

- **SMA on Interstates**
- **Full Deployment of WMA**
- **Use of Anti-Strip Additive**
- **Asphalt Rich Base**
- Optimized Mix Design (i.e. Performance Testing)
Long - Life Asphalt Pavements (LLAP) Construction Specifications

- Longitudinal Joint Density Specification
- RIDE SPECIFICATION
- MTV Required
- Tack Coat Requirements (New Specification)

% WITHIN TOLERANCE (PWT) ACCEPTANCE

- INCENTIVIZE CRITICAL ELEMENTS (I.E. MAT DENSITY)
Optimized or Balanced Mix Design

- Crack Resistant
- Rut Resistant
- Resistant to Moisture Damage
PAPA Proposed Crack Performance Testing

- Virgin vs. 15% RAP mix
- Design Binder vs. +0.5% AC
- Lab mix vs. Production mix
- Short-term vs. long-term aging
- 16 cells in matrix
Balanced Mix Design: ETG Definition

- Asphalt mix design using *performance tests* on appropriately *conditioned specimens* that address *multiple modes of distress* taking into consideration mix aging, traffic, climate and location within the pavement structure.

Performance Pendulum (Shane Buchanan, Oldcastle)
Disk-Shaped Compact Tension (DCT) Test

- ASTM D7313-13
- Loading Rate:
  - Crack Mouth Opening Displacement
  - CMOD Rate = 1.0 mm/min
- Measurements:
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  - Load
Semi-Circular Bend (SCB) Test

- Multiple variants exist
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  - Simultaneous cold (Marasteanu et al. – MN) and intermediate temperature (Mohamed et al. – LA) versions
  - Recent work from Al-Qadi et al. (IL) → AASHTO TP 105

- AASHTO TP 105 (I-FIT)
  - Line load control, loading rate = 50 mm/min
  - Test temperature = 25 deg. C

- Measurements:
  - Displacement
  - Load

- Outcomes
  - Fracture Energy
  - Flexibility Index (FI)
**Fracture Parameters**

Fracture work: Area under Load-Displacement curve

Fracture Energy, $G_f$:
Energy required to create unit fracture surface

\[ G_f = \frac{\text{Fracture Work, } S_f}{\text{Fracture Area}} \]

Flexibility Index, $FI$:

\[ FI = \frac{G_f}{m} \]
Higher RAP Mixes

http://www.asphaltpavement.org/
Higher RAP Mixes

- NCHRP Report 752 (Project 9-46)
- STIC Materials TAG Initiative
- PSU - LTI Task Order #10
- CT S 015-15 Issued
- PAPA had many Questions - Suggestions
Higher RAP Mixes

- Meeting/PennDOT, FHWA and PAPA
- Outcome of Meeting:
  - Move to Replacement Binder Ratio (RBR)
  - Change from 2 Tiers to 3 Tiers
  - Tier 1 – no change (0.20 ≤ 19 mm, 0.25 > 19mm)
  - Tier 2 – consensus properties of aggregate
  - Tier 3 – aggregate and binder testing
  - Standard deviations of RAP properties
- CT Step 2 responses to comments out
- Possible CT 3
HMA WMA Pavement Materials

Asphalt Binders – “Neat” and Modified

Asphalt – the liquid

- The glue that binds the aggregate
- Must be heated to use
- Modified with additives to enhance high temperature performance (e.g.: to improve rutting resistance or cracking)
- Chosen based on climate
The **Performance Grade** of a binder is based on the climate where the pavement is being constructed and describes the probable high and low temperatures the pavement can be expected to reach, in Celsius. In Pennsylvania, that range is primarily 64°C down to minus 22°C but some areas in PA may PG 76-22.
RAP Impact on Performance Grade

- RAP is Reclaimed Asphalt Pavement
- Asphalt in RAP is aged (oxidized) and typically harder compared to virgin asphalt
- For higher amounts of RAP in mixture (greater than RBR=0.25) will need to verify PG of RAP binder and determine required PG of virgin binder.
# JOB MIX FORMULA REPORT

**PennDOT Mix Design Designation Year Number**: 2015 H11

**Supplier Name**: Highway Materials Inc.  
**Location**: PLYMOUTH MEETING PLT # 2

## Supplier Code - Material Class
- **Design ESAL Range**: 0.3 to < 3 Million  
- **Aggregate Skid Resistance Level**: H  
- **Mixture Final PG Binder Grade**: PG6422  
- **Asphalt Mix Type**: HMA  
- **Gradation Classification**: Coarse-Graded  
- **Original Approval Date**: 05

### Material Supplier - Material Code - Class - Product Name - % Material - Spec Grav - % Absorption

<table>
<thead>
<tr>
<th>Material Supplier</th>
<th>Material Code - Class</th>
<th>Product Name</th>
<th>% Material</th>
<th>Spec Grav</th>
<th>% Absorption</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMC46B14</td>
<td>207 (Aggregate Fine)</td>
<td>- B3</td>
<td>26.200</td>
<td>2.808</td>
<td>0.74</td>
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<tr>
<td>AXON3 15</td>
<td>1 (Asphalt Cement)</td>
<td>- PG5628</td>
<td>4.300</td>
<td>1.031</td>
<td></td>
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<tr>
<td>HIM46G41</td>
<td>17 (Hot Rap Design)</td>
<td>- RAP</td>
<td>25.000</td>
<td>2.800</td>
<td>0.00</td>
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<tr>
<td>HMC46A14</td>
<td>207 (Aggregate Fine)</td>
<td>- B1</td>
<td>14.100</td>
<td>2.045</td>
<td>1.24</td>
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<tr>
<td>HMC46B14</td>
<td>203 (Aggregate)</td>
<td>- A8</td>
<td>30.400</td>
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<td>0.49</td>
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<td>PBFOH 15</td>
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## JOB MIX FORMULA AND DESIGN

<table>
<thead>
<tr>
<th>Design Target</th>
<th>Mix</th>
<th># Gravels at NInitial</th>
<th># Gravels at NDesign</th>
<th># Gravels at NMaximum</th>
<th>% Virgin A.C.</th>
<th>% Virgin A.C.</th>
<th>% Virgin A.C.</th>
<th>% Virgin A.C.</th>
<th>% Virgin A.C.</th>
<th>% Virgin A.C.</th>
<th>% Virgin A.C.</th>
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</thead>
<tbody>
<tr>
<td>A.C. Slabs Size</td>
<td>200</td>
<td>500</td>
<td>#100</td>
<td>#30</td>
<td>100</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>5.5</td>
<td>5.0</td>
<td>5.0</td>
<td>5.0</td>
<td></td>
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</tr>
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<td></td>
<td>5.0</td>
<td>7.0</td>
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<td>15.0</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>7.0</td>
<td>55.0</td>
<td>65.0</td>
<td>95.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

## MIX CHARACTERISTICS (LABORATORY)

- **Total Reclaimed Binder Ratio**: 0.22
- **Calc. Asp. Film Thickness**: Fine
- **Total Asphalt (PA) Ratio**: 1.0

## ASPHALT CONTENT TEST METHOD

- **A.C. Test Method**: PTM No. 757
- **External Party Oven Make/Model**: GILSON/HM-378
- **Furnace Temp (°C)**: 538.0
- **Sample Size for C.F.**: 0.42
- **Asphalt C.F.**: 0.42
- **200 C.F.**: 0.30

## MOISTURE SUSCEPTIBILITY DATA

<table>
<thead>
<tr>
<th>A.C. Supplier</th>
<th>Name</th>
<th>Dry PSI Strength</th>
<th>Wet PSI Strength</th>
<th>TSR Value</th>
<th>Date of TSR Test</th>
<th>Date of Boil Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>PBFOH 15</td>
<td>AXON3 15</td>
<td>89.8</td>
<td>103.1</td>
<td>0.87</td>
<td>2/27/15</td>
<td>2/1/13</td>
</tr>
<tr>
<td>SUIT3 15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## COMBINED AGGREGATE CONSENSUS PROPERTIES

- **AASHTO T 176 Sand Equivalency (%)**: 96.0
- **AASHTO T 384 Fine Aggr. Angularity**: 48.7
- **Uncompacted Voids (%)**: 100.0
- **ASTM D5821 - Coarse Aggregate Angularity**: 100.0
- **% 1 Face Crush**: 1.2
- **% 2 Face Crush**: 2.0
- **ASTM D4791 Flat / Elongated Particles**: 75.0

<table>
<thead>
<tr>
<th>Sand Equivalency (%)</th>
<th>Fine Aggr. Angularity</th>
<th>Uncompacted Voids (%)</th>
<th>% 1 Face Crush</th>
<th>% 2 Face Crush</th>
<th>ASTM D4791 Flat / Elongated Particles</th>
<th>Total % Reclaimed Agg. From RAP and/or RAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>96.0</td>
<td>48.7</td>
<td>100.0</td>
<td>1.2</td>
<td>2.0</td>
<td>75.0</td>
<td></td>
</tr>
</tbody>
</table>

**Designed By**: Christopher Boyle  
**Submitted By**: John Savastio  
**Approved By**: John D Mccall
ThinLay

ThinLay - As thin as a Quarter!

http://www.asphaltpavement.org/
ThinLay

DESCRIPTION – This work is the construction of a thin lift wearing course (Called ThinLay) of plant-mixed, dense-graded WMA, 6.33 mm (1/4 inch) Nominal Maximum Aggregate Size (NMAS), on a prepared surface using a volumetric mixture design developed with the Superpave Gyratory Compactor.

ThinLay 6.33 mm WMA wearing course is a preservative treatment used to extend the service life of a pavement without significantly improving the pavements structural capacity. It is intended for use on existing pavements with minor surface distresses like raveling and low-severity cracking and with no structural distresses.

ThinLay 6.33 mm WMA Wearing Course is a virgin mixture design with high asphalt content, placed at 1” or > in depth.
ThinLay Special Provision

- 6.3 mm – 100% passing 3/8 in.
- Dense –graded (6 sieve sizes) - SRL
- PG 76-22 polymer modified asphalt
- N design = 75 gyrations
- Design voids = 4.0%
- Min. VMA = 16.5
- No RAP or RAS
- Place at greater than 50 F
- Optimum Rolling Pattern
Use Guidelines

- Only on structurally sound pavement
- Substitute for micro-surfacing
- For correcting surface distresses only
- Consider grinding PCC first
Compaction

- **Due to 1” + overlay, mat cools quickly.**

- **Rollers.** Use an adequate number of static steel-wheel rollers as specified in Section 108.05(c)3 to keep up with the continuous paving operation and having a manufacturer’s certified metal weight of not less than 10 tons.
  
  - Operate rollers according to manufacturer's recommendations. Use rollers equipped with a watering or soapy watering system that prevents material from sticking to the rollers. **Do not use pneumatic-tire rollers.**

- **Do not use rollers in vibratory mode** unless it can be demonstrated during the trial demonstration specified in Section III.(p) of this special provision and to the satisfaction of the Inspector in Charge that no detrimental effect to the pavement structure results from the vibration.
ThinLay

- PennDOT conducted a study of 4 ThinLay projects over the past three years. A final research report has been drafted and awaiting approval.

- A CT of proposed specifications was out for review and comment.

- A SSP should be available soon for use in projects and incorporation in PUB 408, PUB 272, etc. by next spring.

- Any asphalt producer will be able to make this product.
Thin overlays are an added solution to pavement preservation. They are economical, long-lasting, and effective in treating a wide variety of surface distresses to restore ride quality, skid resistance, and overall performance.

https://www.youtube.com/watch?v=Udk8DTh4rJl
Porous (Permeable) Asphalt Pavements
In PENNSYLVANIA

J.D. Eckman Parking Lot, Atglen, PA
PA Porous (Permeable) Asphalt Pavements

- More stringent Stormwater Mgt. Ordinances
- % Impervious Surfaces
- Various BPM’s
- Unique Specifications for Porous Pavements
PA Porous (Permeable) Asphalt Pavements

- Reference Material Utilized
  - NAPA – IS-115 & IS-131
  - UNH Stormwater Center - Design Specifications for Porous Asphalt Pavements –
  - MNDOT – Porous Asphalt Pavement Performance in Cold Regions
PA Porous (Permeable) Asphalt Pavements

- Advantages Identified
  - Reduced Surface Run Off
  - Recharge Ground Water
  - Replace “Open” Retention Basins
  - Allow for Additional Parking Space
PA Porous (Permeable) Asphalt Pavements

- Results From STIC TAG Spec Project
  - PUB 408, Section 420 – Pervious Bituminous Pavement System
  - PUB 242, Appendix M – Pervious Surface Course Design
  - PUB 594, Chapter 14.7 – Pervious Pavement
  - PUB 23, Maintenance Manual
PA Porous (Permeable) Asphalt Pavements

- Pervious System Design

FIGURE K.1
PERVERIOUS SYSTEM DESIGN

Pervious Surface Course

Choker Course AASHTO No. 57

AASHTO No. 57

OR

AASHTO No. 3

1.5

Class 4A - non woven separation geotextile on bed sides, not bottom

(Lay back slope or shore/trench).

Type A or B fine aggregate 2" minimum

Uncompacted Subgrade: Perform percolation test for basin design per ASTM D3385

* Sloped or vertical sides - as designed

Depth based on volume of detention basin needed for a minimum of a 25-yr rain event. Overflow designs may be considered for a 100-yr rain event.

Typically 6" - 36"
PA Porous (Permeable) Asphalt Pavements

- Pervious Pavement Construction
  - 2 Test Sections – Check Permeability Using ASTM C1701
  - **DO NOT** Compact Subgrade
  - Sand Bottom/Class 4 Geotextile on Sides
  - 6”-36” Crushed Rock Reservoir
  - Compact Crushed Aggregate and Bituminous Layers Using 10 Ton Steel Wheeled Loader in Static Mode (1-4 Passes)
PA Porous (Permeable) Asphalt Pavements

- Pervious Pavement Maintenance Requirements
  - **DO NOT** Use Sand or Anti-Skid
  - Pressure Wash and/or Vacuum Surface Annually
  - Monitor or Test Permeability Periodically
  - **DO NOT** Surface Seal
New Tack Coat Specification Requirements Section 460
Tack Coat

- CSS-1h tack coat (60% residue)
- 0.06 Gal/SY tack application rate
- 0.04 Gal/SY min residue on pave
Change in Tack material

- New Tack is similar to CSS-1h emulsified asphalt.
  - The Minimum residual asphalt is 57% instead of 28%
  - The application temperature is 90F to 150F (AET - 75F to 140F)

- Non-tracking Tack is also an option now.
  - Minimum residual asphalt is 50%.
## Change to Application Rate

<table>
<thead>
<tr>
<th>Surface Type</th>
<th>Uniform Asphalt Residue Rate (RR) (Gallons per square yard)</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Bituminous Paving</td>
<td>0.03 to 0.05</td>
</tr>
<tr>
<td>Existing Bituminous Paving</td>
<td>0.04 to 0.07</td>
</tr>
<tr>
<td>Milled Surface (Bituminous &amp; PCC)</td>
<td>0.04 to 0.08</td>
</tr>
<tr>
<td>Portland Cement Concrete</td>
<td>0.04 to 0.07</td>
</tr>
</tbody>
</table>
Test Section

• The specification includes a test section.
  ▫ 100 Ft. test section required to ensure the proper application is being applied.
Happenings - [www.pa-ashalt.org](http://www.pa-ashalt.org)

- Feb. 2-9 Mid-Atlantic QAW
- March 15 PAPA Central Regional Tech Mtg
  March 14 PAPA Western Regional Tech Mtg
  March 16 PAPA Eastern Regional Tech Mtg
- Aug. 1-2 PAPA/DOT Bus Tour-District 6

Please Contact Tina Holtzman @ 717-657-1881 or [tina@pa-ashphalt.org](mailto:tina@pa-ashphalt.org) for more Information!
Questions??        Thank you!!

To contact ........................................

Pennsylvania Asphalt Pavement Association
3540 North Progress Avenue, Suite 206, Harrisburg, PA 17110-9647
www.pa-asphalt.org
717-657-1881

Charles C Goodhart, Executive Director – cgoodhart@pa-asphalt.org
Gary L Hoffman, P.E. Director of Technical Services – gary@pa-asphalt.org

Committed To:
Safe, Smooth, Sustainable, Long Lasting Pavements!
A FREE Simplified Pavement Design Tool
What Is PaveXpress?

“A free, online tool to help you create simplified pavement designs using key engineering inputs, based on the AASHTO 1993 and 1998 supplement pavement design process.”

• Accessible via the web and mobile devices
• **Free** — no cost to use
• Based on AASHTO pavement design equations
• User-friendly – Drop down menus
• Share, save, and print project designs
• Interactive help and resource links
Brief Overview

- Software developed & updated by NAPA
- Provide **FREE** online tool to develop technically sound pavement designs for roadway pavements
- Provide a user-friendly, visually appealing, pavement design tool accessible to users on a variety of devices
- Provides a **FREE** alternative to ACPA Streetpave
- Provide resources to enhance understanding and comfort with asphalt pavement design
AASHTO has developed MEPDG software (PavementME) for high volume roads, but a gap has developed for local roads and lower volume roads. Thus the impetus for PaveXpress provides technically sound pavements designs using:

- Flexible: AASHTO ’93
- Rigid: AASHTO ‘93 w/ ‘98 Supplement
- Parking lot guidance (Flexible only)
• Utilize for new pavement designs (several DOTs testing)

• Utilize for design of overlay projects (Version 2)

• Municipal Engineering Consultants are utilizing

• Utilize as a comparator for pavement designs
A Free Simplified Pavement Design Tool

www.PaveXpressDesign.com
AASHTOWare Pavement ME Design (Version 2.2)

Pavement ME Design is the next generation of AASHTOWare® pavement design software, which builds upon the mechanistic-empirical pavement design guide, and expands and improves the features in the accompanying prototype computational software. ME Design supports AASHTO's Mechanistic-Empirical Pavement Design Guide, Interim Edition: A Manual of Practice. ME Design is a production-ready software tool to support the day-to-day pavement design functions of public and private pavement engineers.
Effects of PennDOT Implementation of the AASHTO ME

• Development of the MEPDG

  • How the Pavement Design got to where it is at this time (from AASHTO 1961 to Present)

  • AASHTO Road Test 1958-60

  • Procedures used for 40 years

  • PennDOT to implement this year
AASHO Road Test (late 1950’s)
AASHTO Pavement Design Guide

- Empirical methodology based on AASHO Road Test in the late 1950’s

- Several versions:
  - 1986, 1993 (Same equation, additional inputs)

- Many deficiencies after 40 years!
Current AASHTO vs. Current Needs

- **AASHTO Design Guide**: 1 set of materials
- **AASHO Road Test**: 1 climate/2 years
- **Limited structural sections**
- **50+ million loads**
- **1.1 million load reps**
- **Wide range of structural and rehabilitation designs**
- **All climates over 20-50 years**
- **New and diverse materials**
AASHTO MEPDG

• Development of the MEPDG
  • The MEPDG is based on mechanistic empirical design concepts.

  • **Mechanistic:** Design procedure calculates pavement responses such as stresses, strains, and deflections under axle loads and then accumulates the damage over time.

  • **Empirical:** Damage is correlated with actual performance of pavements.

• **MEPDG vs. AASHTO ‘93.**
**Some Specific Advantages: HMA**

<table>
<thead>
<tr>
<th>Old AASHTO 1960-93</th>
<th>New AASHTO ME Design</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Structural design provides only SN, not HMA thickness!</td>
<td></td>
</tr>
<tr>
<td>• No connection of asphalt binder grade to performance</td>
<td></td>
</tr>
<tr>
<td>• HMA &amp; base layer coefficients not accurate</td>
<td></td>
</tr>
<tr>
<td>• ESALs used for traffic</td>
<td></td>
</tr>
<tr>
<td>• Climate not considered</td>
<td></td>
</tr>
<tr>
<td>• Rehab does not consider reflection cracking</td>
<td></td>
</tr>
<tr>
<td>• Directly provides HMA thickness to prevent fatigue cracking &amp; rutting</td>
<td></td>
</tr>
<tr>
<td>• Asphalt binder grade directly related to fatigue cracking, rutting, and low temp cracking</td>
<td></td>
</tr>
<tr>
<td>• HMA dynamic modulus &amp; creep compliance meas.</td>
<td></td>
</tr>
<tr>
<td>• Actual axle loads &amp; types</td>
<td></td>
</tr>
<tr>
<td>• Climate directly considered</td>
<td></td>
</tr>
<tr>
<td>• Rehab directly considers reflection cracking</td>
<td></td>
</tr>
</tbody>
</table>
DG Inputs
Axle load (lb)

Materials & Construction
Structure, Joints, Reinforcement

Climate

DG Process
Distress Prediction & Reliability

Mechanistic Response
Damage Accumulation

Comprehensive System

Damage

Time

Distress

Damage Accumulation

Field Distress

DG Outputs

Load (lb)
AASHTO ME Basics

• MEPDG Basics Design options within the software
  
  • New or reconstructed AC pavement
  • New or reconstructed Jointed Plain Concrete Pavement (JPCP)
  • AC Rehabilitation - AC overlay on existing AC
  • AC Rehabilitation - AC overlay on existing JPCP
  • JPCP Rehabilitation - Concrete Pavement Restoration (CPR diamond grinding) and Unbonded JPCP overlay on an existing JPCP
AASHTO ME Basics: Some Details

• MEPDG Basics
  • Guidance to perform pavement design using the software. Iterative process and including the following steps:
    • Trial design input.
    • Analysis by the software, including key distresses, and IRI.
    • Predicted performance is compared to the design performance criteria at a desired level of reliability. Modified designs are reentered into software and analysis is performed again.
Improved Engineering Design

• Due to its comprehensive development & calibration to local pavement performance, the new AASHTO ME provides far more accurate design! This translates into lower construction & maintenance/rehab costs over time.

• Then, **design reliability** is then used to provide a safety factor in structural design. Higher traffic typically requires higher design reliability.

• **Certain distresses**, such as bottom up fatigue cracking can justify higher design reliability also, due to its importance in good performance and high maintenance/rehab requirements.
MEPDG - Pavement ME

PennDOT IS IMPLEMENTING Pavement ME

- Software developed by AASHTO
- Updated via NCHRP Projects
- Hired Firm, ARA, to assist with implementation 2015
- Fall 2015 started to calibrate software
- Spring – started training for users
- July 1, 2016 – begin designing pavements with Pavement ME

http://www.aashtoware.org/Pavement/Pages/default.aspx
# MEPDG - Pavement ME

## Cost of Pavement ME License

<table>
<thead>
<tr>
<th>Description</th>
<th>Annual License Fee</th>
</tr>
</thead>
<tbody>
<tr>
<td>Individual Workstation License</td>
<td></td>
</tr>
<tr>
<td>Individual Workstation</td>
<td>$5,000</td>
</tr>
<tr>
<td>Site License</td>
<td></td>
</tr>
<tr>
<td>Site License – Up to 9 concurrent users</td>
<td>$20,000</td>
</tr>
<tr>
<td>Site License – Up to 14 concurrent users</td>
<td>$30,000</td>
</tr>
<tr>
<td>Site License – Up to 20 concurrent users</td>
<td>$40,000</td>
</tr>
</tbody>
</table>
Getting Quality Pavement Joints

Longitudinal Joint Specification
Performance
Goal – Better Densities

• Our focus has been on getting better joint density due to performance issues of under compacted material.
Goal - Better Densities

“The amount of air voids in an asphalt mixture is probably the single most important factor that affects performance throughout the life of an asphalt pavement.”
- E. Ray Brown, NCAT Report 90-3

“Compaction is the most important factor in the performance of an HMA pavement.”
- HMA Paving Handbook, US Army Corps of Engineers
Result - Better Densities

On our RPS and NHS routes we have gained in terms of density.

<table>
<thead>
<tr>
<th>Year</th>
<th>Min. Spec. Limit</th>
<th>Avg. Joint Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>N/A</td>
<td>88.9%</td>
</tr>
<tr>
<td>2009</td>
<td>N/A</td>
<td>89.2%</td>
</tr>
<tr>
<td>2010</td>
<td>N/A</td>
<td>88-90%</td>
</tr>
<tr>
<td>2011</td>
<td>≥ 89%</td>
<td>91.0%</td>
</tr>
<tr>
<td>2012</td>
<td>≥ 89%</td>
<td>91.6%</td>
</tr>
<tr>
<td>2013</td>
<td>≥ 89%</td>
<td>91.4%</td>
</tr>
<tr>
<td>2014</td>
<td>≥ 90%</td>
<td>92.3%</td>
</tr>
<tr>
<td>2015</td>
<td>≥ 90%</td>
<td>92.6%</td>
</tr>
</tbody>
</table>
Longitudinal Joints

- 124 Projects with Specification
- 493 Total Lots (2464 cores) approx. 1167 miles
- Raised min. spec. limit to ≥ 90% density for 2014 construction (Pub. 408 2011/Change 5)

2015 Longitudinal Joint Density Projects Incentive/Disincentive Summary

<table>
<thead>
<tr>
<th>Pay Adjustment</th>
<th>Total $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonus</td>
<td>$1,620,868</td>
</tr>
<tr>
<td>Negative Adjustment</td>
<td>$149,851</td>
</tr>
</tbody>
</table>
Increased Projected Life of Joints Due to Improved Densities in PA, 2008 thru 2015

Projected service life curve based on a Washington state study.
Joint Density Up

- We have done well in raising the density at our joints. This will pay off.

- Now let’s focus on making sure we get the density without causing cracking.
Goal - Dense Joints that Don’t Crack

- Better densities mean more roller passes
- More roller passes mean more chance to crack the pavement in the area of the joint
- Tender mixes will make this tendency worse. Be on your guard to ensure you are not creating cracking.
Note the overhang… this needs to be on every pass, not just some of them.
What We Don’t Want

Edge of drum inside unsupported edge
Can cause cracking near the edge and lateral mix movement at the unsupported edge (especially on tender mixes)

Rolling Unsupported Edge
(First Paver Pass)

Edge of drum inside unsupported edge
Can cause cracking near the edge and lateral mix movement at the unsupported edge (especially on tender mixes)
What We Don’t Want

• Note the crack that formed at the unsupported edge.

• This illustrates why rolling just inside of the edge is not desirable.

• This mix had a tender zone and cracks formed at the edge of the roller drum.
Make sure rollers overhang edges
Watch what is Going on at the Screed

Project:
- Paved June 2015
- Wedge Joint
- No joint spec
- Paver leaving shadow in mat about 3” from joint
- Next winter?

- Often watching the mat closely can pick up an issue that could be corrected
Tack at Unsupported Edges

- Apply tack coat slightly beyond the edge of the lane to be paved

Extra Tack Coat Width
You Want to See Tack Coat

Note the extra 6 inches of tack
Overlap Paver Screed 1” (to 1 ½”)

- Consistent proper overlap is key
- Operate paver so that the edger plate on the screed overlaps the previously placed pavement by 1 inch (to 1 ½ inches)
Conclusion

• **Density is important, so get it**
• **Watch details so cracking doesn’t happen**
  • Roller passes, overhang
  • Roller speed
  • Stay out of tender zone
  • Tack application
  • Watch the screed
  • Use your eyes to look for issues
Implementation

- CT1 comments addressed.

- CT 2 should be out in a week or 2

- Specification should be approved by July 1.

- Change should be in Change 1 of 2016 Pub. 408.
  - Change 1 effective date is October 7, 2016.
  - In contracts effective December 16, 2016
Tack Coat Specification
ASPHALT PAVEMENT DISTRESS

TYPES & REPAIRS
TYPES OF PAVEMENT DISTRESS

- **Cracking**
  - Fatigue
  - Transverse
  - Block
  - Edge
- **Potholes**

- **Surface Deformation**
  - Rutting
  - Corrugation/ Shoving
  - Slippage Cracks

- **Surface Defects**
  - Raveling
  - Bleeding
  - Polishing
Select Appropriate Repairs for Observed Distresses

- Non-Structural vs. Structural Problems
Specific Methods of Bituminous Repairs

- Patching
- Crack Sealing
- Surface Treatment
  - Seal Coat
  - Slurry Seal
  - Micro-surfacing
  - Non-structural overlay
  - ThinLay
- Full Depth Reclamation
- Structural Overlay
Late Season Paving

2015 PENNDOT – PAPA BUS TOUR
SOL 495-15-08 Issued August 17, 2015

SUBJECT: Asphalt Weather Restrictions/Requests to Extend the Paving Season

- **Policy & Procedure to Revise Pub 408, Section 409.3(b) – Weather Limitations**
- **Issued as a Standard Special Provision (SSP)**
  - SSP included in all projects let after 08-14-2015
  - Will be included in next PUB 408 update
SOL 495-15-08 What changed?

SUBJECT: Asphalt Weather Restrictions/Requests to Extend the Paving Season

- **Extension Time Period** – **March 15 to April 1 & October 31 to November 20**

- **Submit Written Request to DE**
  - Provide justification with a work schedule - paving plan
  - Use Warm Mix Asphalt
  - Agree to supply WMA at or below HMA unit price
  - Agree to no additional costs for means, methods, or materials
  - Complete work by approved completion date

- **A Final Acceptance Certificate will not be issued to May 1 of the following year for November work**
What still needs to change?
Asphalt Weather Restrictions/Requests to Extend the Paving Season

- **Eliminate all date restrictions**
  - A number of State DOT’s have moved to “no date” specification (MD, KS, CA, NJ & OK)

- **Retain wet surface restriction & air and pavement surface temperature of 40°F – 35°F if WMA used**
Urban RAP
Urban RAP Opportunity

- More RAP Being generated than recycled
- 2.9 + Million Tons in D 6 – NJ has over 11 Million Tons
- Will become a bigger issue in future
- What do we do?
- PAPA Proposal to PAG
  - Generate less RAP – ThinLay
  - Higher RAP Mixes
  - 100% RAP Mixes
  - FDR Projects
  - Logistics Study
  - Suggestions
- Task Force to be formed to study – make recommendations