Hot Mix Asphalt
PWL Specifications
in Kansas

Rick Barezinsky, P.E.
Field Materials Engineer
Kansas DOT
OVERVIEW

- PWL History in Kansas
- PWL Usage (Air Voids)
- PWL Usage (Density)
- Additional Requirements
• PWL since October 2000
• ½ the desired incentive/disincentive
  – Reduce Contractor Risk
• January 2003
  – Density
    • Max Incentive = 4.0%
    • Max Disincentive = 16.0%
  – Air Voids
    • Max Incentive = 3.0%
    • Max Disincentive = 12.0%
PWL History in Kansas

• Prior to PWL (06/1996 - 10/2000)
  – Density
    • Tables
      – $\frac{1}{2}$ based on the Avg Density
      – $\frac{1}{2}$ based on Lowest Avg Sublot Density
  – Air Voids
    • Deviation from the target (4.0% @N_{des})
PWL USAGE (Air Voids)

- $V_a @ N_{des}$ for all HMA mixes
  - 90 PWL is required for Full Pay (AQL)
  - 50 PWL is RQL

DOUBLE-LIMIT SPECIFICATION

percent defective

percent within limits

$LSL = 3.0\%$

$USL = 5.0\%$
Comparing the Test Results

- Lot Size Begins at 3,000 Tons
  - 4 Contractor QC Tests per Lot
  - 1 Agency Verification Test per Lot
  - Compare using F&t

- F&t Tests for Air Voids
  - Compare both Variances and Means
  - Significance Level = 0.01
  - Up to 5 Lots of Data Compared
  - Same Means - Use Contractor’s Data
  - Different Means - Use Agency’s Data
**PWL USAGE (Air Voids)**

- **V_a PWL Equations**
  - Determine Quality Indices

  
  
  \[
  Q_{uv} = \frac{USL - \bar{X}}{S} \quad \quad \quad Q_{lv} = \frac{\bar{X} - LSL}{S}
  \]

- **PWL Equations**
  - Find the PWL for both the upper and lower Quality Indices

  \[
  P_v = \left( \left( PWL_{uv} + PWL_{lv} - 100 \right) \times 0.0030 \right) - 0.270
  \]

Pay Adjustment = Tons in Lot * $40/Ton * P_v
Air Void Pay Adjustments for All HMA Projects

\[ P_V = \left( \left( PWL_{UV} + PWL_{LV} - 100 \right) \times 0.0030 \right) - 0.270 \]
**PWL USAGE (Air Voids)**

- Combinations of the Average and Standard Deviation that will get maximum bonus

<table>
<thead>
<tr>
<th>Average</th>
<th>Max Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>0.07</td>
</tr>
<tr>
<td>3.5</td>
<td>0.33</td>
</tr>
<tr>
<td>4.0</td>
<td>0.66</td>
</tr>
<tr>
<td><strong>4.2</strong></td>
<td><strong>0.53</strong></td>
</tr>
<tr>
<td>4.5</td>
<td>0.33</td>
</tr>
<tr>
<td>4.9</td>
<td>0.07</td>
</tr>
</tbody>
</table>
## PWL USAGE (Air Voids)

<table>
<thead>
<tr>
<th>Year</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
<th>Year</th>
<th>N</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>581</td>
<td>4.26</td>
<td>0.40</td>
<td>2003</td>
<td>570</td>
<td>4.34</td>
<td>0.74</td>
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<tr>
<td>2004</td>
<td>531</td>
<td>4.15</td>
<td>0.36</td>
<td>2004</td>
<td>523</td>
<td>4.24</td>
<td>0.76</td>
</tr>
<tr>
<td>2005</td>
<td>527</td>
<td>4.18</td>
<td>0.35</td>
<td>2005</td>
<td>524</td>
<td>4.26</td>
<td>0.67</td>
</tr>
<tr>
<td>2006</td>
<td>158</td>
<td>4.22</td>
<td>0.30</td>
<td>2006</td>
<td>156</td>
<td>4.17</td>
<td>0.66</td>
</tr>
<tr>
<td>AVG</td>
<td></td>
<td>4.20</td>
<td></td>
<td>AVG</td>
<td></td>
<td>4.25</td>
<td></td>
</tr>
</tbody>
</table>
The image contains a chart titled "AIR VOIDS - ALL" for the period from January 2003 to December 2003. The chart shows the distribution of percent air voids with histograms for different categories. The summary statistics for the data are provided, including:

- **N**: 581
- **Mean**: 4.26
- **Std Deviation**: 0.40

The chart also includes a second histogram for a different category with summary statistics:

- **N**: 570
- **Mean**: 4.34
- **Std Deviation**: 0.74

These statistics are likely related to quality control or material testing in a construction or similar field.
VA PWL Yearly Comparisons
2004

AIR VOIDS – ALL
FOR THE PERIOD: 01-2004 thru 12-2004
Report Date: October 23, 2006

SUMMARY STATISTICS
N = 531
Mean = 4.15
Std Deviation = 0.36

SUMMARY STATISTICS
N = 523
Mean = 4.24
Std Deviation = 0.76
Air Voids — All

For the period: 01-2005 thru 12-2005
Report Date: October 23, 2005

SUMMARY STATISTICS
N  527
Mean  4.18
Std Deviation  0.35

SUMMARY STATISTICS
N  524
Mean  4.26
Std Deviation  0.67
VA PWL Yearly Comparisons
2006

AIR VOIDS – ALL
FOR THE PERIOD: 01-2006 thru 12-2006
Report Date: October 23, 2006

CONTRACTOR SUMMARY STATISTICS
N 158
Mean 4.22
Std Deviation 0.30

KDOT SUMMARY STATISTICS
N 158
Mean 4.17
Std Deviation 0.66
<table>
<thead>
<tr>
<th>Year</th>
<th>Earned Incentive</th>
<th>Maximum Incentive</th>
<th>% of Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>$169,233</td>
<td>$375,092</td>
<td>45%</td>
</tr>
<tr>
<td>2003(1/2)</td>
<td>$285,410</td>
<td>$376,541</td>
<td>76%</td>
</tr>
<tr>
<td>2004</td>
<td>$895,853</td>
<td>$1,541,712</td>
<td>58%</td>
</tr>
<tr>
<td>2005</td>
<td>$873,705</td>
<td>$1,661,944</td>
<td>53%</td>
</tr>
<tr>
<td>2006</td>
<td>$344,074</td>
<td>$499,309</td>
<td>69%</td>
</tr>
</tbody>
</table>
PWL USAGE (Density)
PWL USAGE (Density)

- In-Place Density ($%G_{mm}$)
  - 90 PWL is required for Full Pay (AQL)
  - 50 PWL is RQL
  - One-Sided Specification
    - LSL = 91.0% (Thickness ≤ 2”)
    - LSL = 92.0% (Thickness > 2”)
    - Lot Size is a Day’s Production
    - 10 Contractor QC Tests per Lot
    - 5 Agency Verification Test per Lot
    - Compared using F&t

- Only Used on Major Modification Projects (3R and 4R)
Testing

• Typically Using Nuclear Density Gauges
• Cores may be cut and $G_{mb}$ determined
• Day’s Production is Divided into 5 Sublots
  – 2 Contractor QC Tests per Sublot
  – 1 Agency Verification Test per Sublot
Comparing the Test Results

- F&t Tests for Density
  - Compare both Variances and Means
  - Significance Level = 0.01
  - **One** Lot of Data Compared
  - Same Means - Use Contractor’s Data
  - Different Means - Use Agency’s Data
PWL USAGE (Density)

- Density PWL Equations
  - Determine Quality Index

\[ Q_{LD} = \frac{X - LSL}{S} \]

- PWL Equations
  - Find the PWL lower Quality Index

\[ P_D = (PWL_{LD} * 0.004) - 0.360 \]

Pay Adjustment = Tons in Lot * $40/Ton * \( P_D \)
\[ P_D = (PWL_{LD} \times 0.004) - 0.360 \]
Density PWL Comparisons
2005 (Avg Diff = 0.1%)
Density Non-PWL Comparisons 2005 (Avg Diff = 0.5%)
PWL Usage (Thickness)

- Not QC/QA Testing
- All measurements done by agency
- 5 Sublots per Lot
- 90 PWL is full pay (AQL)
- 50 PWL is RQL
- LSL
  - Mainline = Plan Thickness - ½"
  - Shoulder = Plan Thickness - ¾"
- Max Incentive = 3.0%
- Max Disincentive = 12.0%
Additional Requirements

• Technician Certification Program
  – KSU (Salina and Manhattan)
  – National Certifications
  – KDOT Training
• Laboratory Certification Program
  – AASHTO Accredited (AAP)
• Equipment Calibration Program
  – NIST Traceable equipment
• Independent Assurance Testing
• Inspection
• Contractors Involved in Process
Conclusions

Pay Adjustments using PWL tend to tighten the Contractor’s Process Control

The incentives and disincentives should be balanced and fair

Involve Partners in the Implementation and Refinement of the Specifications

Include a Certification Program

Continue Project Inspection
Hot Mix Asphalt
PWL Specifications
in Kansas

Questions?