Illinois Tollway – Key Statistics

- 286-mile system comprised of four tollways:
  - Tri-State (I-94/I-294/I-80)
  - Jane Addams Memorial (I-90)
  - Reagan Memorial (I-88)
  - Elgin O’Hare (IL-390)
  - Veterans Memorial (I-355)
- Opened in 1958 as a bypass around Chicago to connect Indiana and Wisconsin
- Carries more than 1.4 M vehicles per day
- User-fee system – no state or federal gas tax dollars used for maintenance and operations
Nearly $6 Billion Committed
99.9% complete
• Completed Rebuild & Widen Projects systemwide
• Built 12.5-mile I-355 South Extension
• Converted 20 barrier toll plazas to Open Road Tollsing
Move Illinois Capital Program

- Take Care of Existing System Needs
- Jane Addams Memorial Tollway $2.5 billion
- Elgin O'Hare Western Access $3.4 billion
- I-294/I-57 Interchange $719 million
- Illinois Route 53/120 Project
Move Illinois and Sustainability

- **Move Illinois** will be the "cleanest and greenest" program in the Tollway's history.
  - Minimizes the environmental impact of new roadway construction by reducing, recycling and reusing materials.
  - Commits to incorporating renewable energy products including solar panels, wind turbines and geothermal systems.
  - New and existing infrastructure projects including maintenance site reconstruction will seek a recognized green project standards and certification for Leadership in Energy and Environmental Design (LEED).
Sustainability Means a Lot at the Tollway

Nearly 1.4 million tons of recycled concrete, asphalt and aggregate in the construction of new roads – enough to build a nearly 2,700-mile bike path from Boston to San Francisco.
Three Legs of Sustainability to be Equal
Specifications Have Different Risk Profiles

- Owner/Designers
- Contractor

Type of Specification:
- Method
- QC/QA
- End-Result
- Performance/Warranty
Implementation of Performance Specifications

- Summer to Fall 2013 – Shadow Implementation
- March 2014 – meeting with Tollway Engineering Management to get approval to move forward
- March to May 2014 – Development of specification framework
- July 2014 – 1st Meeting with Industry to provide overview of PRS & present concept/ideas
- July 2014 – First draft of SP
- Fall to Winter 2014 – Multiple meetings revising and changing SP
- April 2015 – Training on testing and procedures
- May 2015 to Current – Performance specifications in effect
Shadow Performance Specifications

- Develop and evaluate like **FULL** implementation
- Does not impact contractor pay for the shadow project
- Learning and pre-implementation tool
Performance Specifications Applied to Larger Concrete Paving Projects Starting in 2015

- Project would have at least 10 sublots
- Will be evaluated and determined by Tollway
- Pay factors will be different by corridor
Steps for Implementation of Performance Specifications

1. **Conduct project coordination meetings**
   - select location, gather information, develop sampling & testing plan

2. **Collect and analyze historical data**
   - AQCs, M & R criteria, costs, discount rate, etc.

3. **Develop and evaluate pay factors**
   - PaveSpec, historical evaluation
Steps for Implementation of Performance Specifications

4. **Prepare for implementation on project**
   layout of lots & sublots, sampling & testing details

5. **Develop Special Provisions**
   followed by meetings, presentations, revisions

6. **Conduct field sampling and testing**
   database management, dispute resolution

7. **Evaluate PRS results**
   Incentives/disincentives for each lot
Develop Pay Factors

Pay Factor $f(\Delta LCC)$

Establish Performance Criteria

Identify AQCAs and Target Values

Compare As-Built and As-Designed

Model ME Performance

PAVESPEC

Design AQC vs. As-Constructed AQC

Quality

Design

Constructed

Distress & IRI

As-Designed

As-Constructed

Pavement Age

M&R Plan

Planning
Use Pay Factors

Incorporate Pay Tables Into Specifications & Project Letting

Pavement Construction, Sampling, and Testing

Incentive and Disincentive Pay
First Define Acceptance Quality Characteristics (AQC’s)

- **Measureable**
- More rapid the better
- **Correlate with performance**
- Prediction models
- **Are under contractor’s control**
- Can be varied on the project
Acceptance Quality Characteristics (A QC s)

- **Five A QC s**
  - Compressive strength
  - Air
  - Thickness
  - Smoothness
  - Dowel Alignment

- **Each has**
  - Target
  - Rejectable level
  - Maximum level

All A QC tests MUST be tested with random sampling
Levels of Pavement Quality

- **Target Quality Level (TQL)**
  - At target 100% pay
  - Near target pay adjustment (incentive/disincentive)

- **Rejectable Quality Level (RQL)**
  - Corrective measures required

- **Maximum Quality Level (MQL)**
  - No further incentive
Lots and Sublots

- **Lot**: All mainline concrete
- **Sublot**: Division of a lot for testing and sampling
  - One lane wide and ~1,000 ft. long (Generally 700 – 1,300 ft.)
  - Provisions for pavement blockout
    - Access areas, bridge approach, ramp transition, etc.
- **Sublot limits marked on plans (by lane)**
- **Payment is made on lot basis**
- **Rejection is made on subplot basis**
Non-Conforming Materials

- If RQL not met, contractor to develop Corrective Action Plan
- No incentive/disincentive for a sublot with non-conforming materials.
- Accept or reject concrete on a sublot basis.
Pavement Type Selection Report (LCCA) is the Construction PRS Basis

- Traffic
- Design
- Reliability & Performance Criteria
- Support conditions
- M & R strategies
- Costs & other miscellaneous data
# Maintenance and Rehabilitation Strategy

<table>
<thead>
<tr>
<th>Year</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Construct new JPCP with HMA shoulders</td>
</tr>
</tbody>
</table>
| 11   | Mainline—Reseal 100% transverse joints (TJ) and 100% longitudinal joints (LJ)  
Shoulder—Rout and seal all cracks; Apply microsurface |
| 18   | Mainline—Concrete full-depth patching (3.5% of area); Reseal 100% TJ and 100% LJ  
Shoulder—Rout and seal all cracks; Apply microsurface |
| 25   | Mainline—Concrete full-depth patching (5.0% of area); Diamond grind; Reseal 100% TJ and 100% LJ  
Shoulder—Rout and seal all cracks; Apply microsurface |
| 30   | Mainline—Concrete full-depth patching (6.0% of area); Apply 4.0-in SMA overlay  
Shoulder—Apply 4.0-in HMA overlay |
| 38   | Mainline—Rout and seal all cracks  
Shoulder—Rout and seal all cracks |
| 44   | Mainline—Remove 4.0-in SMA; Concrete full-depth patching (7.0%); Apply 4.0-in SMA overlay  
Shoulder—Rout and seal all cracks; Apply microsurface |

*Varies as-constructed vs. as-designed*
Historical AQC Data

- Means and Standard Deviations
- IMIRS (Illinois Materials Inspection and Reporting System) database
  - Compressive strength, air content
- Historical QC/QA data over last 2-5 years
  - Smoothness, thickness
- Other sources
  - National historical dowel alignment data
**PaveSpec 4.0**
Mechanistic-Empirical Models and AQC

<table>
<thead>
<tr>
<th>Input</th>
<th>Significantly Impact Distress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transverse Cracking</td>
</tr>
<tr>
<td><strong>Initial Smoothness</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>PCC Strength</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>PCC Thickness</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>PCC CTE</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>Effective Dowel Diameter</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>PCC air content</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PCC mix w/c ratio</strong></td>
<td>X</td>
</tr>
</tbody>
</table>

*Computed by measuring dowel alignment & NCHRP 10-69 procedure*
Pavement ME (MEPDG)

General Information
Performance Criteria and Reliability
Traffic Climate
Structure/Materials Design Features
Pavement ME Structural Response Model

- **ISLAB2000**—enhanced 2.5D Finite Element Method
- **Rapid solution method required to make millions of calculations rapidly**
  - Neural network with dimensional analysis and equivalent system
  - Modified MC-HARP and traditional back-propagation neural networks
Pavement ME Seasonal Variation of Inputs

Each load application

CTB Modulus

PCC Modulus

Traffic

AC Modulus

Granular Base Modulus

Subgrade Modulus

Time, years
Relating Structural Responses to Distresses

Pavement Response

- Stresses
- Deflections

TRANSFER FUNCTION

Transfer Function Nationally Calibrated Coefficients

Pavement Distress

- Cracking
- Faulting
# PaveSpec 4.0

## Mechanistic-Empirical Models and AQCs

<table>
<thead>
<tr>
<th>Input</th>
<th>Significantly Impact Distress</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transverse “Slab”</td>
</tr>
<tr>
<td><strong>Initial Smoothness</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>PCC Strength</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>PCC Thickness</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>PCC CTE</strong></td>
<td>X</td>
</tr>
<tr>
<td><strong>Effective Dowel Diameter</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PCC air content</strong></td>
<td></td>
</tr>
<tr>
<td><strong>PCC mix w/c ratio</strong></td>
<td>X</td>
</tr>
</tbody>
</table>

*Computed by measuring dowel alignment & NCHRP 10-69 procedure*
PaveSpec 4.0

Performance Related Specification Development
# PCC Layer Inputs

![Screenshot of PaveSpec 4.0 interface](image)

## Specification Development

- Design
- Lanes Configuration
- Performance and AQC
- Sampling and Testing
- Structure
- Traffic
- Climate
- Maintenance and Rehabilitation
- Unit Costs
- Simulation Control

## Data Input Libraries

### Layer Structure

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit Weight (pcf)</td>
<td>150.0</td>
</tr>
<tr>
<td>Poisson’s Ratio</td>
<td>0.2</td>
</tr>
<tr>
<td>Curing Method</td>
<td>Membrane</td>
</tr>
<tr>
<td>Time to 50% of Ult. Shrinkage (days)</td>
<td>35</td>
</tr>
<tr>
<td>Depth of Shrinkage (in)</td>
<td>2.0</td>
</tr>
<tr>
<td>Cementitious Content (lbs/yd^3)</td>
<td>550</td>
</tr>
<tr>
<td>Cement Type</td>
<td>1</td>
</tr>
<tr>
<td>PCC Spacing Factor (Air Voids)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

*ARA Illinois Tollway*
Vehicle Classification Distribution

[Image of a computer interface showing vehicle classification distribution]

- General Inputs
- Monthly Distribution
- Vehicle Distribution
- Axle Distribution
- Truck Configuration

<table>
<thead>
<tr>
<th>Class</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 4</td>
<td>1</td>
</tr>
<tr>
<td>Class 5</td>
<td>3</td>
</tr>
<tr>
<td>Class 6</td>
<td>3</td>
</tr>
<tr>
<td>Class 7</td>
<td>5</td>
</tr>
<tr>
<td>Class 8</td>
<td>3</td>
</tr>
<tr>
<td>Class 9</td>
<td>65</td>
</tr>
<tr>
<td>Class 10</td>
<td>10</td>
</tr>
<tr>
<td>Class 11</td>
<td>3</td>
</tr>
<tr>
<td>Class 12</td>
<td>3</td>
</tr>
<tr>
<td>Class 13</td>
<td>4</td>
</tr>
</tbody>
</table>

Total: 100.00%
8 Maintenance & Rehab Inputs

To define this rehabilitation plan step, complete the following sentence:

If IRI is greater than 170 in/mile

then begin global rehab scenario 3

and continue to the next step

If IRI is greater than 170 in/mile then begin global rehab scenario 3 and continue to the next step

If average transverse joint faulting exceeds 0.1 in then begin global rehab scenario 3 and continue to the next step

If percent cracked slabs (cumulative) exceeds 10% then do full slab replacements to 100% of cracked slabs and continue to the next step

If percent spalled joints (cumulative) exceeds 5% then do partial depth repair to 100% of spalled joints and continue to the next step
Why Use Performance Modeling for PF?

Rational and defensible pay factors to provide a measure of the value of quality that is directly related to performance
28-Day Compressive Strength

- Test with cylinders (Illinois Modified AASHTO T22, T23)
  - Process described in IDOT Article 1020.09 Strength Tests
  - 6”x12” cylinders only
- Two cylinders per subplot

<table>
<thead>
<tr>
<th>Level</th>
<th>Mean (psi)</th>
<th>Std. Dev. (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>5,500</td>
<td>500</td>
</tr>
<tr>
<td>Rejectable</td>
<td>4,000</td>
<td>-</td>
</tr>
<tr>
<td>Maximum</td>
<td>6,500</td>
<td>-</td>
</tr>
</tbody>
</table>
Strength Pay Factor Curve

Pay Factor, %

28-Day Compressive Strength, psi

Std. Dev. = 500 psi
Std. Dev. = 1,000 psi
Std. Dev. = 0 psi
Air Content

- **Test with pressure meter according to IDOT Article 1020.08 Air Content**
- **Computed from average of four tests per subplot**
  - Same samples used for strength cylinders + 3 others

<table>
<thead>
<tr>
<th>Level</th>
<th>Mean Content (%)</th>
<th>Std. Dev. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>6.5</td>
<td>0.5</td>
</tr>
<tr>
<td>Rejectable</td>
<td>5.0</td>
<td>-</td>
</tr>
<tr>
<td>Maximum</td>
<td>9.0</td>
<td>-</td>
</tr>
</tbody>
</table>
Air Content Pay Factor Curve

![Chart showing the relationship between entrained air content and pay factor, with different standard deviations.](chart.png)
Slab Thickness

- **Test with MIT-Scan T2 meter as described by user manual**
- Random pre-determined locations
- **Computed from average of four measurements per sublot**

<table>
<thead>
<tr>
<th>Level</th>
<th>Mean (in)</th>
<th>Std. Dev. (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Plan thickness</td>
<td>0.25</td>
</tr>
<tr>
<td>Rejectable</td>
<td>Plan thickness - 0.5</td>
<td>-</td>
</tr>
<tr>
<td>Maximum</td>
<td>Plan thickness + 1.0</td>
<td>-</td>
</tr>
</tbody>
</table>
Slab Thickness Pay Factor Curve

- Pay Factor, %
- PCC Thickness, in

- Std. Dev. = 0.25 in
- Std. Dev. = 0.50 in
- Std. Dev. = 0 in
Smoothness (IRI)

- Test in accordance with ASTM E950
  - Class I inertial profiler
- Test and report each wheel path
- Computed from average of wheel paths

<table>
<thead>
<tr>
<th>Level</th>
<th>Mean (in/mile)</th>
<th>Std. Dev. (in/mile)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>60.0</td>
<td>10.0</td>
</tr>
<tr>
<td>Rejectable</td>
<td>80.0</td>
<td>-</td>
</tr>
<tr>
<td>Maximum</td>
<td>50.0</td>
<td>-</td>
</tr>
</tbody>
</table>
Smoothness Pay Factor Curve

- Std. Dev. = 10 in/mi
- Std. Dev. = 20 in/mi
- Std. Dev. = 0 in/mi
Effective Dowel Diameter (EDD)

- Test with MIT-Scan 2
- Calculate EDD as described in NCHRP Report 637
- Averages of five consecutive joints
- Rejection on individual alignment criteria
- Process control separate of PRS

<table>
<thead>
<tr>
<th>Level</th>
<th>Mean (in.)</th>
<th>Std. Dev. (in.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>1.50</td>
<td>N/A</td>
</tr>
</tbody>
</table>
Effective Dowel Diameter Pay Factor Curve

Pay Factor, %

Effective Dowel Diameter, in
Lot Composite Pay Factors

\[ PF_{lot} = \left( \frac{PF_{str}}{100} \right) \cdot \left( \frac{PF_{air}}{100} \right) \cdot \left( \frac{PF_{thk}}{100} \right) \cdot \left( \frac{PF_{smth}}{100} \right) \cdot \left( \frac{PF_{dowel}}{100} \right) \times 100 \]

**Maximum Composite PF: 105%**

**Minimum Composite PF: 85%***

*Provided AQCs meet the RQL standards
Spreadsheets to Track Construction Quality Data

This draft spreadsheet was developed by Applied Research Associates, Inc. for the Illinois Tollway. It is used for computing the pay adjustment according to the performance-related specifications for rigid pavements as specified in:

PERFORMANCE-RELATED PORTLAND CEMENT CONCRETE PAVEMENT, JOINTED – 13 INCH (Tollway Effective: September 1, 2014)

Please go to tabs Strength PF, Thickness PF, Effective Dowel Diameter PF, Air Content PF, Smoothness PF and enter information as requested. Once information is entered on those tabs, enter bid price and conforming area below for total pay adjustment.

Data distributed to all through Ebuilder

<table>
<thead>
<tr>
<th>Strength Pay Factor</th>
<th>no</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thickness Pay Factor</td>
<td>na</td>
</tr>
<tr>
<td>Dowel Diameter Pay Factor</td>
<td>na</td>
</tr>
<tr>
<td>Air Content Pay Factor</td>
<td>na</td>
</tr>
<tr>
<td>Smoothness Pay Factor</td>
<td>na</td>
</tr>
<tr>
<td>Calculated Composite Pay Factor</td>
<td>na</td>
</tr>
<tr>
<td>Adjusted Composite Pay Factor</td>
<td>na</td>
</tr>
</tbody>
</table>

Enter Bid Price and Conforming Area below:

- **BID PRICE ($/sq. yd.):**
- **CONFORMING AREA (sq. yd.):**

**Total Pay Adjustment ($):** na
Performance Specifications Started With Tollway Concrete Material Specs for Patching

- Back in 2008, hundreds of long life full depth PCC patches were required on a Chicago area Tollway expressway
- CTL Group was hired to come up with a solution to make them fast but long life
- Performance Engineered Mixes (PEM’s) and the specifications for them resulted
Current Tollway Applications for PEM Specs

- Accelerated (HES) weekend patching mixes
- Rapid Ca Al cement overnight patching mixes
- Mass concrete PCC mixes for structures
- HPC bridge deck / approach slab PCC mixes
- Ternary black rock PCC mixes for composite pavements
- Ternary optimized PCC mixes for single lift pavements
## Performance Requirements for HPC Deck Mixes

<table>
<thead>
<tr>
<th>Test Method</th>
<th>Performance Requirement</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>AASHTO T 22-10</td>
<td>$4000 \leq f'<em>{cr} \leq [f'</em>{cr} + 1500]$ psi at 14 days</td>
<td>14 days</td>
</tr>
<tr>
<td>AASHTO T 119</td>
<td>Slump greater than 3&quot; for 45 minutes after water added to cement</td>
<td>0</td>
</tr>
<tr>
<td>ASTM C1581-09a</td>
<td>Minimum 28 days with no cracking <em>(Exempt if &lt; than 600 lb/yard³ cementitious &amp; &gt; of 1.5 gal/yard³ SRA is used)</em></td>
<td>28 days</td>
</tr>
<tr>
<td>AASHTO T 160-09</td>
<td>Maximum 0.03 percent after 7 days curing and 21 days drying, zeroed at the start of drying</td>
<td>28 days</td>
</tr>
<tr>
<td>AASHTO T 161(A)-08</td>
<td>Minimum RDM of 80 percent after 300 cycles <em>(Exempt if ASTM C457 requirements are met and aggregate is IDOT Class A+)</em></td>
<td>74 days typ.</td>
</tr>
<tr>
<td>AASHTO T 303</td>
<td>Expansion less than 0.10% at 16 days <em>(Exempt if total alkali content from cement is &lt; than 4 lb/yard³)</em></td>
<td>16 days</td>
</tr>
<tr>
<td>ASTM C457-11</td>
<td>Spacing factor not exceeding 0.008-in Specific surface not less than 600 in²/in³ Total air content not less than 4.0%</td>
<td>7 days</td>
</tr>
<tr>
<td>AASHTO T 277-07</td>
<td>Max 1250 Coulombs after 28 day accelerated curing</td>
<td>28 days</td>
</tr>
</tbody>
</table>
Success to Date with PEM for HPC Decks

- Since 2012, 28 HPC bridge decks placed along I-90. Many more coming this year.

- Isolated shrinkage cracks found on only one of the bridges.

- Isolated restraint cracks found on only 12 of the 28 decks.

- Can we make the specs more strict?
Recommendations to Agencies on Developing PEM Specifications

- Reach out to the experts for ideas
- Collaborate with your local roadbuilders
  - Road and bridge builders associations
  - Local ACPA chapters
- Train the field staff (for new testing)
- Most importantly, develop the specs through the local concrete suppliers and chapter ACI group or NRMCA!
- Don’t wait for the Professors!
All Future Pavement Construction to Use Only Performance Related Optimized Ternary Mixes

- Between 2014 and 2026, more than a million cu. yds. of performance related ternary pavement mixes to be produced for new Chicago expressways.
- Mixes will require a minimum of 35% SCM’s except with cold weather placements.
- Blended cements allowed.
- Feed of washed chips to optimize gradation is mandatory.
- More than 500,000 cu yds to be placed on I-90 in 2015 & 2016.
Summary of 2015 implementation of Performance Specifications at Tollway

- Applied to nine I-90 reconstruction and widening projects with 13” JPCP
- No. of sublots ranged from 20 to 120 per contract
- Approx. 1,443,512 sq. yds. of JPCP to be built under Performance Specifications in 2015 & 2016
- Approx. 300k sq. yds. placed to this date.
Results to Date as of: **11/02/2015**

### Percent of Sublots with data (by Contract)

<table>
<thead>
<tr>
<th></th>
<th>G</th>
<th>W</th>
<th>J</th>
<th>Z</th>
<th>A</th>
<th>Q</th>
<th>X</th>
<th>M</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>90.0</td>
<td>84.1</td>
<td>64.2</td>
<td>20.0</td>
<td>38.2</td>
<td>20.5</td>
<td>58.8</td>
<td>57.1</td>
<td>60.9</td>
</tr>
<tr>
<td>Strength</td>
<td>75.0</td>
<td>66.0</td>
<td>34.2</td>
<td>18.8</td>
<td>8.8</td>
<td>17.8</td>
<td>14.7</td>
<td>35.7</td>
<td>34.8</td>
</tr>
<tr>
<td>Thickness</td>
<td>100.0</td>
<td>75.7</td>
<td>56.7</td>
<td>17.5</td>
<td>29.4</td>
<td>20.5</td>
<td>55.9</td>
<td>71.4</td>
<td>52.2</td>
</tr>
<tr>
<td>Dowel Diam.</td>
<td>95.0</td>
<td>67.3</td>
<td>60.0</td>
<td>17.5</td>
<td>33.8</td>
<td>17.8</td>
<td>55.9</td>
<td>67.9</td>
<td>43.5</td>
</tr>
<tr>
<td>Smoothness</td>
<td>55.0</td>
<td>0.0</td>
<td>1.7</td>
<td>13.8</td>
<td>0.0</td>
<td>8.2</td>
<td>23.5</td>
<td>0.0</td>
<td>4.3</td>
</tr>
</tbody>
</table>

Overall: 37.8 Percent of sublot/data for the pay factor types have some data

### Quality Pay Factors by Type and Contract

<table>
<thead>
<tr>
<th></th>
<th>G</th>
<th>W</th>
<th>J</th>
<th>Z</th>
<th>A</th>
<th>Q</th>
<th>X</th>
<th>M</th>
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Values have no or insufficient sublot data and are only used for the Composite PF calculation.
Issues Encountered or Lessons Learned

Compressive strength limits were the biggest issue
- At early age
- At 28 days
Issues Encountered or Lessons Learned

Mix Designs More Important

- Allow for slight mix design adjustments to be quickly approved (7 days)
- Be prepared for many trial batches
- Make the Contractor responsible for preparing and delivering compressive strength cylinders
- Make sure agency’s labs cure and test properly

Good Measurement Critical

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Issues Encountered or Lessons Learned

- Plan for the hand pours or manual placements
  - Allow for subplot boundaries to be adjusted
  - Locations of manual placement paid for at bid price with no adjustment potential
  - Minimum properties required to be obtained as measured using QC/QA, not PRS
- Smoothness measurements delayed when new pavement is used as a haul road in narrow work zones
- Don’t let the contractor sneak in his own QC data
Issues Encountered or Lessons Learned

- Possibly account for cold weather placements
  - Reduce SCM content in mixes after the need for cold weather protection arrives
  - Create second lot with compressive strengths and smoothness pay factors eliminated from composite pay factor for all placements afterwards
2015 PRS Construction Revision

- **Mix Designs**
  - 3-day Strength – reduced to 2500 psi
  - Mix Design adjustments – faster approval (7 days)

- **Pavement PRS**
  - Strength Testing Calculation (Third Cylinder)
  - Strength Pay Factor adjusted
  - Dispute response time: revised from 3 to 14 days
  - Blockouts / Handpours defined and preapproved
  - Late Season Paving accounted for
Benefits to Performance Specifications

- Improved design-to-construction communication
- Develop more rational pay factors
- Improved and focused testing by all parties
- Improved understanding of performance by all
- Improved quality focus
- Clearer distinction in roles and responsibilities
- Creates a more innovative environment
- Most importantly – overall cost savings!
Recommendations to Agencies on Developing PRS Specifications for JPCP

- Specify most objective procedures for measurement of quality characteristics to minimize dispute resolution battles with the contractors.
- Be prepared for agency to be totally responsible for taking measurements.
- Allow for 1 to 3 year warranties to still be used with the promise to the industry to reduce them or eliminate them should PRS show improvements down the road.
- Shadow current projects to establish database to base future PRS quality characteristic limits on.
Next Tollway Endeavor with PRS

- Develop PRS for continuously reinforced concrete pavements
- Being re-engineered by the Tollway through ARA, U of I, Texas A & M, and Oregon State to be more dependent on the performance of mix and more economical to build
- Start to develop PRS for asphalt mixes and pavement construction
THANK YOU
Develop and Deploy Performance-Related Specifications (PRS) for Pavement Construction

FHWA DTFH61-13-C-00025

Murthy Guddati, Pat Nolan, Gerry Huber
Develop and Deploy Performance-Related Specifications (PRS) for Pavement Construction

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Phase 1
- Development of PRS models and software
  - Asphalt and Jointed Plain Concrete Pavements
- Guidelines development
- Deployment projects and PRS validation

Phase 2
- Sensitivity analysis
- Software integration
- Inspection and material testing program optimization
- PRS refinements

Phase 3
- Pay factor weighting evaluation
- Risk evaluation
- PRS final refinements
Develop and Deploy Performance-Related Specifications (PRS) for Pavement Construction

- WHAT WE ARE WORKING ON RIGHT NOW (PCC)
  - Improved durability models for PCC
  - Improvement to PaveSpec 4.0
  - Speed
  - Analysis Engine
  - Life-Cycle Cost Analysis
  - User Costs
  - Sampling/Testing Details and Lot/Sublot Analysis
  - Incorporation of durability models into PaveSpec
  - Guideline documents
Interested in Shadow Implementation?

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