Construction Management Utilizing Performance Related Specification for Concrete Pavement

The Illinois Tollway Story

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Vice President & Principal Engineer
Outline

About the Illinois Tollway & I-90 Project

Performance Related Specifications

Tollway Specification Implementation & Summary
Illinois Tollway System Overview

286-mile system comprised of four Tollways
- Tri-State (I-94/I-294/I-80)
- Jane Addams Memorial (I-90)
- Reagan Memorial (I-88)
- Veterans Memorial (I-355)

Opened in 1958 as a bypass around Chicago to connect Indiana and Wisconsin

Carries more than 1.4 million vehicles per day

User-fee system – no state or federal gas tax dollars used for maintenance and operations
I-90 Jane Addams Memorial Tollway

$2.5 billion of capital program

62 miles of roadway

Western section completed in 2014

Eastern Section completed in 2016
Life Cycle Cost is the Basis for PRS Pay Factors

Design

As-Built
Life Cycle Cost is the Basis for PRS Pay Factors

Rational and defendable pay factors provide a measure of the value of quality that is directly related to performance.
Acceptance Quality Characteristics are Key

Measureable
• More rapid the better

Correlate with performance
• Prediction models

Are under contractor’s control
• Can be varied on the project
### PCC PRS is Not a New Concept

#### Shadow Specification Projects
- Iowa: Shadow spec project 1996
- New Mexico: Shadow spec project 1997
- Missouri: Shadow spec project 1997
- Kansas: Shadow spec project 1997
- Wisconsin: Shadow spec project 1997

#### Full Specification Projects
- Indiana: Full spec projects I-465 (Indianapolis), I-65 (Clarksville), and I-70 (Indianapolis) in 2000-2003
- Florida: Full spec project I-295 (Jacksonville) in 2002
- Tennessee: Full project I-65 (Nashville) in 2002
- Wisconsin: Two Full projects I-39/90/94 (Madison) in 2006 and 2008
### PRS Implementation was a Process

<table>
<thead>
<tr>
<th>Time Frame</th>
<th>Events</th>
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<tr>
<td>Summer ‘13</td>
<td>• Shadow Specification</td>
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<tr>
<td>March ‘14</td>
<td>• Engineering Management Approval</td>
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<td>March-May ‘14</td>
<td>• Develop Specification</td>
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<td>• Multiple Stakeholder Meetings</td>
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<td>May ‘15</td>
<td>• Specification in effect</td>
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Shadow Specification was Key to Implementation

- Develop and evaluate like FULL implementation
- Does not impact contractor pay for the shadow project
- Learning and pre-implementation tool
Acceptance Quality Characteristics (AQCs)

Five AQCs
- Compressive strength
- Air
- Thickness
- Smoothness
- Dowel Alignment

Each has
- Target
- Rejectable level
- Maximum level

All AQC tests MUST be tested with random sampling
Pre-Construction Preparation

- Sublot Designation
- Data Management
- Contractor Interface
- Training
Sublots are Designated on the Plans

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Random Test Locations Determined by IA

IA provides excel spreadsheet

Air, strength, thickness, and dowel bar locations
e-Construction Processes for Data Management

Created new process within existing project documentation management system

Submit data

Review; Accept or Dispute

Track Process Completion
Education and Training is Key to New Specifications

Contractor

Contractor QC

Construction Management Team

QA Technicians and Lab
Construction

Each AQC Has Its Own Process
PRS Testing Process: DAY BEFORE

Material Coordinator identifies sublots Contractor is planning to pave

- Make any location or subplot adjustments if necessary
- Notify IA of any subplot adjustments

IA places thickness plates in identified sublots

QA obtains cylinder molds
PRS Testing Process: DAY OF

QA
• Label compressive strength cylinder molds
• Date, contract, Sublot, air test #, mix design, station, lane, QA lab identification
• Provide lids or bags
• Perform air tests at designated locations, 4 per sublot

Material Coordinator provides IA with sublots paved, lanes paved, paving limits

QC
• QC conducts testing per IDOT QC/QA
• Casts four 28 day compressive strength specimens for each sublot at locations identified by QA
• Designates safe place for cylinders on job site
Plastic Air Content

Measured by Quality Assurance (QA)

At random station location

4 tests per subplot

6.5% target

Data entered into Tollway’s material data management system: I-MIRS
28 Day Compressive Strength Specimens

Measured by Quality Assurance

Contractor casts specimens and delivers to lab

1 random station location tied to plastic air test per sublot

6,500 – 7,000 psi target

Data entered into Tollway’s material data management system: I-MIRS
PRS Testing Process: DAY AFTER

**QA uploads air content results to I-MIRS**
- Material Coordinator reviews air content reports, confirms accuracy, and acknowledges

**QC delivers strength specimens to QA lab**
- QA lab inspects all cylinders for any damage

**IA measures thickness and dowel bar alignment**

**Contractor cleans joints for dowel bar alignment testing**
Pavement Thickness Measurement

IA measured with MIT Scan T2

6 plates; 4 will be used for pay factor

All 6 locations will be measured
Dowel Alignment Testing

IA performed testing with MIT Scan2

5 joints scanned at random location per sublot

Data used to calculate Effective Dowel Diameter (EDD)
- 1.50 target

Scan dowel baskets and DBI
**EDD Calculated per NCHRP 10-69**

**Contract:** 15-4236

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**Additional Information:**

- **Dowel Diameter (inches):** 1.50
- **PCC Thickness (inches):** 13.0
- **Scan Direction Outside Joint to Inside Joint:** N (Y = Yes OR N = No)
- **Slab Width (ft):** 12.0
PRS Testing Process: 28+ Days After

At 28 days, QA tests cylinders and uploads compressive strength results to I-MIRS

- Material Coordinator reviews strength reports, confirms accuracy, and acknowledges
Smoothness Data Collection

IA measured with truck mounted inertial profiler

Smoothness measured in each wheel path of each subplot

International Roughness Index (IRI)

80 in/mi target

Allowed retesting
What if QC Does Not Match QA?

**Air Content**
- Retest at construction
- Backup air meter
- Hardened air

**Compressive Strength**
- 4 cylinders cast closest 2 are used

**Dowel Alignment**
- Rescan

**Thickness**
- Rescan
- Core over scan location

**Smoothness**
- Retest
There Were Construction Issues…

LOT 2
The Results Matter
# 2015 PRS Pay Results

## Lot 1 Quality Pay Factors by Type and Contract

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<th>B</th>
<th>C</th>
<th>D</th>
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### Lot 1 Composite Pay Factor

*99.6*

## Lot 2 Quality Pay Factors by Type and Contract

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### Lot 2 Composite Pay Factor

*102.1*

## 2015 Overall Construction Estimate (11/18)

*100.5*
### 2015 Results

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*2015 Overall Construction Estimate (11/18)* 100.5

### 2016 Results

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*2016 Overall Construction Estimate (11/18)* 101.9
PRS Specification Development Was a Process

Shadow Specification (FHWA Supported)

Management Approval

Industry Participation

Test Procedures & Data Procedures
Benefits to PRS

- 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
Thank You
Backup Slides
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
28-day Compressive Strength Adjustment

Pay Factor, %

- 2015/2016 FINAL
- Original SP

28-day Compressive Strength (psi)
Test Data submitted through standard, materials information process

- Air data collected onsite
- Four tests per sublot; Average value reported for sublot
- Pay Factor based on Mean and Standard Deviation of sublot values for Lot and interpolated based on the following table
PCC Thickness Quality Characteristic

Measured Using MIT T-2 Device
- Metal discs placed at randomly generated locations
- Six discs placed, only four thickness readings taken
- Average of four readings reported for each sublot
- Mean and Standard Deviation based on sublot values
- Measurements repeated if grinding performed

Dowel Bar Alignment Quality Characteristic

Measured Using MIT Scan Device
- Five consecutive joints scanned at random location
- Joint score and effective dowel bar diameter calculated for each joint
- Average of five readings reported for each sublot
- Mean and Standard Deviation based on sublot values
- No incentive for this QC, max PF is 100
Pavement Smoothness Quality Characteristic

Measured Using High Speed Profiler
- Continuous elevation measurements taken in right and left WP for entire sublot
- IRI calculated for each WP
- Average of two WP readings reported for each sublot
- Mean and Standard Deviation based on sublot values