



Performance Related Specifications for Concrete Pavement Construction

Illinois Tollway's Experience

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U.S. Department of Transportation
Federal Highway Administration

AMERICAN ASSOCIATION
OF STATE HIGHWAY AND
TRANSPORTATION OFFICIALS

AASHTO

Capital - Springfield

Area - 57,914 sq. miles (25th)

Population - 12,830,632 (5th)

Illinois

Professional Sports Teams

Chicago Cubs (National Baseball League)

Chicago White Sox (American Baseball League)

Chicago Bears (National Football League)

Chicago Bulls (National Basketball Association)

Chicago Blackhawks (National Hockey League)

Chicago Machine (professional Lacrosse)

Chicago Sky (Women's National Basketball Association)

State Symbols

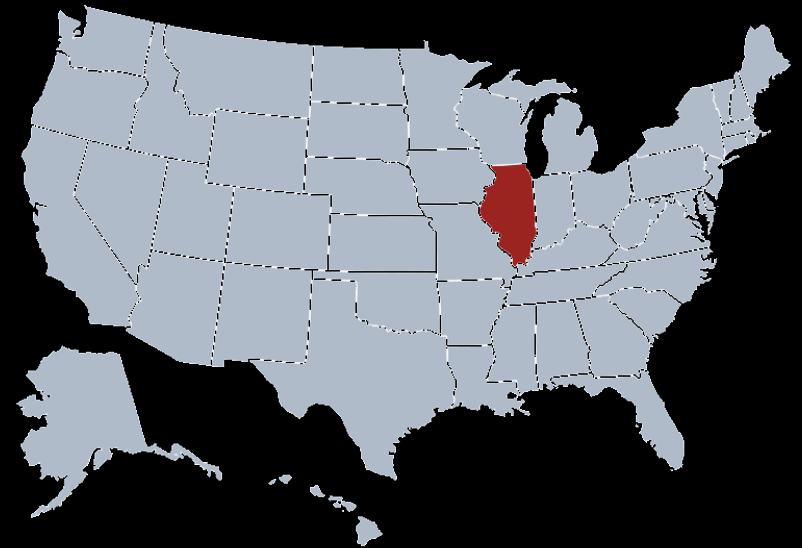
Bird – Cardinal

Animal – White-tailed Deer

Flower – Violet

Tree – White Oak

Insect – Monarch





World's
largest bottle
of catsup



Worlds Largest
Bakery at 1.8M SF

Twinkies were invented on April 6, 2930
in River Forrest, IL



Originated
Ice Cream
Sundae



DID YOU KNOW...?

The world's first farm silo

was invented in Spring Grove, IL.



80% of Illinois
is Farmland



Drummer Soil
is official soil of
Illinois



WELCOME TO
CHARLES MOUND
HIGHEST POINT
IN ILLINOIS

1235 FEET ABOVE SEA LEVEL

Wayne & Jean Wuebbels, Owners

Praise Our Lord Jesus Christ!
In Him We Have Eternal Life.

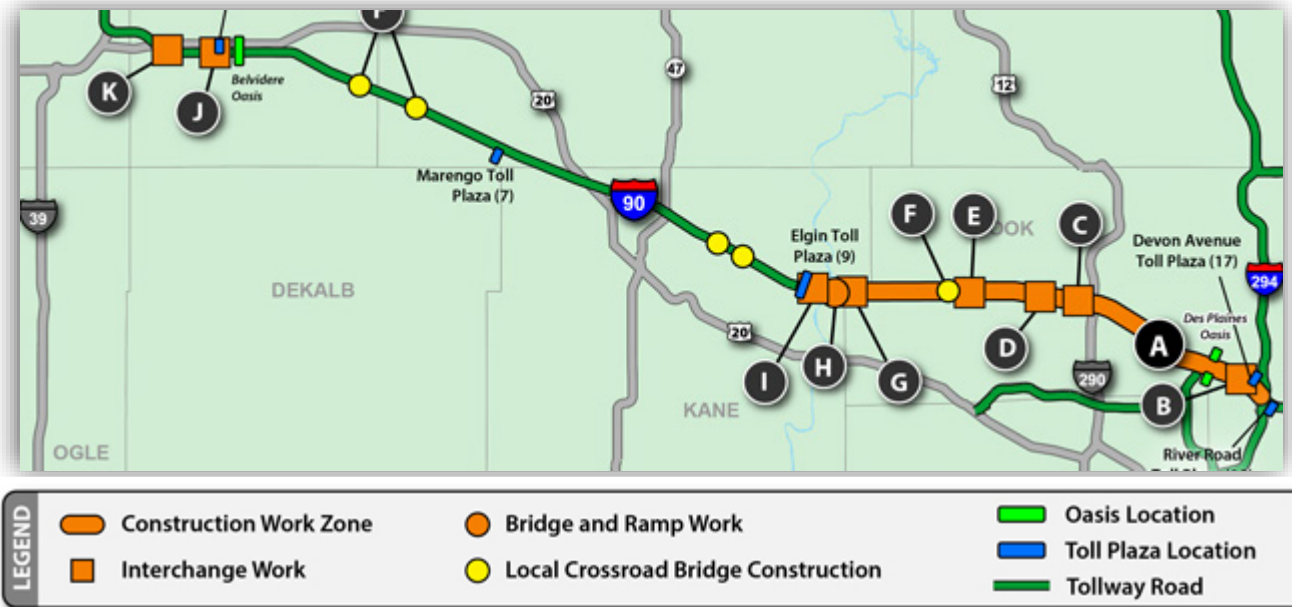


*Where our Governors
make our license plates*



Project is I-90 from O'Hare airport to Rockford

- Project part of Move Illinois capital program
 - 15-years, \$12-billion
- I-90 Reconstruction/ Widening
 - PRS applied to mainline paving contracts
 - 9 contracts in 2015 / 9 contracts in 2016
 - 2015 contracts \$500 million / \$50 million in PRS-JPCP



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 special provision
- Fall to Winter 2014 – Multiple meetings revising and changing SP
- April 2015 – Training on testing and procedures
- May 2015 – Performance specifications in effect

Shadow Performance Related Specifications

- Develop and evaluate like FULL implementation
- Does not impact contractor pay for the shadow project
- Learning and pre-implementation tool



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**
 - AQC's, 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

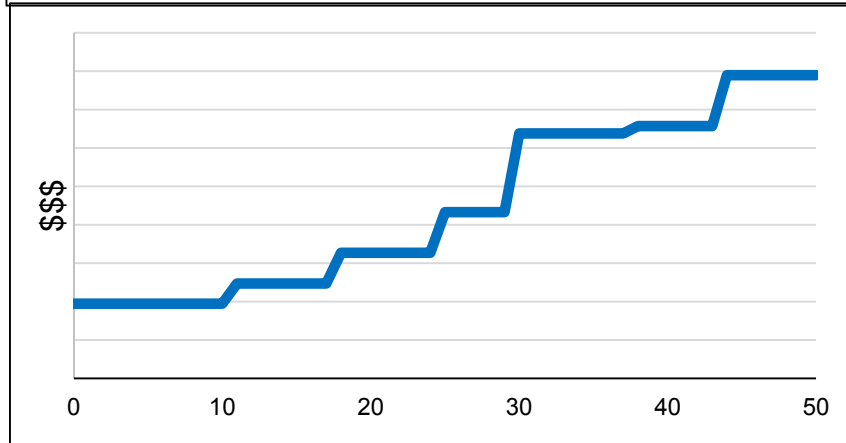
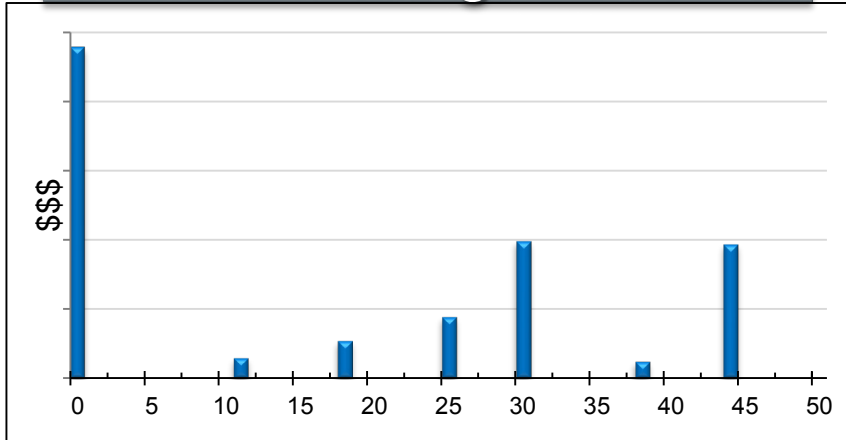
Pavement type selection report (LCCA) is the PRS basis

- Traffic
- Design
- Reliability & Performance Criteria
- Support conditions
- M & R strategies
- Costs & other miscellaneous data

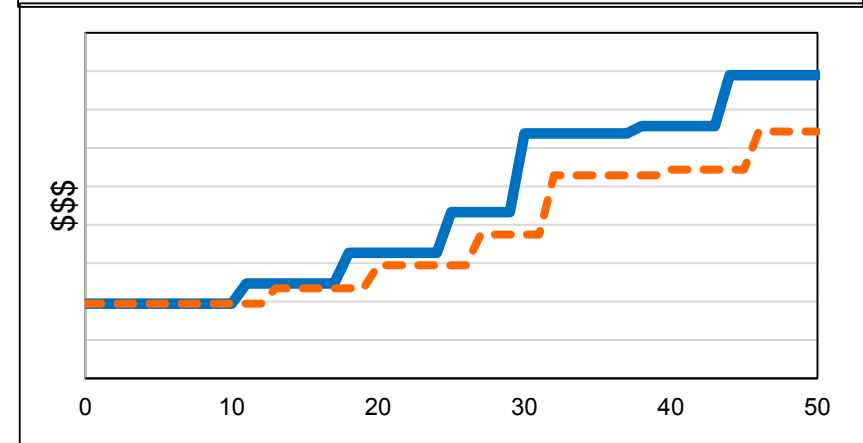
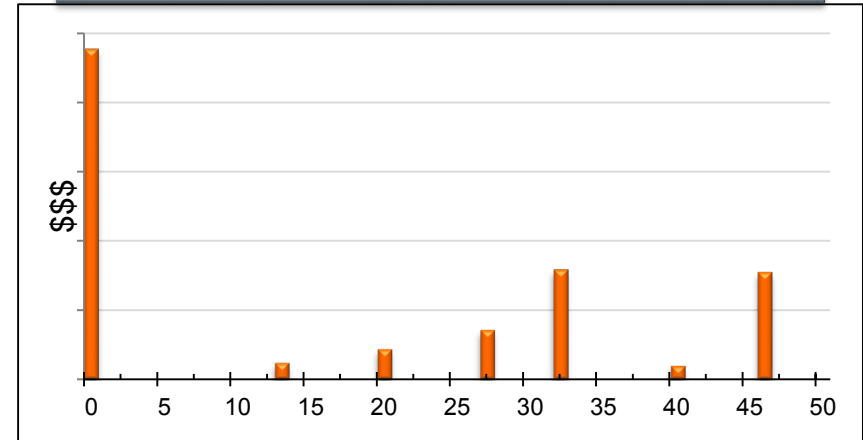


Use Life Cycle Cost as basis for PRS pay factor

Design



As-Built



Rational and defensible pay factors to provide a measure of the value of quality that is directly related to performance

Pavement Design

Develop Specifications

Planning

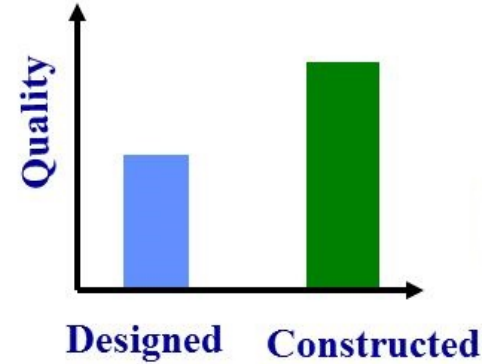


Establish Performance Criteria



Identify AQC's and Target Values

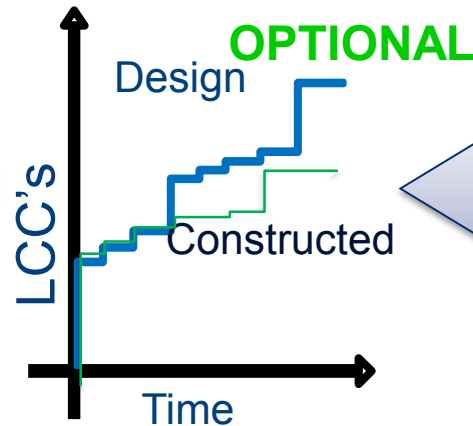
PAVESPEC



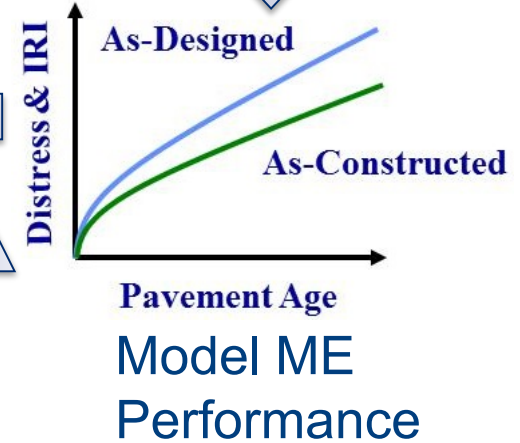
Design AQC vs. As-Constructed AQC



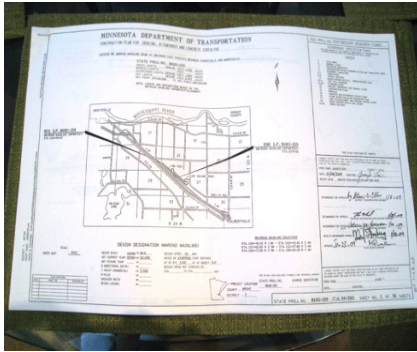
Pay Factor $f(\Delta LCC)$



Compare As-Built and As-Designed



M&R Plan



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 (AQC's)

- **Five AQC's**
 - Compressive strength
 - Air
 - Thickness
 - Smoothness
 - Dowel Alignment
- **Each has**
 - Target
 - Rejectable level
 - Maximum level

All AQC tests **MUST** be tested with random sampling

Lots and Sublots

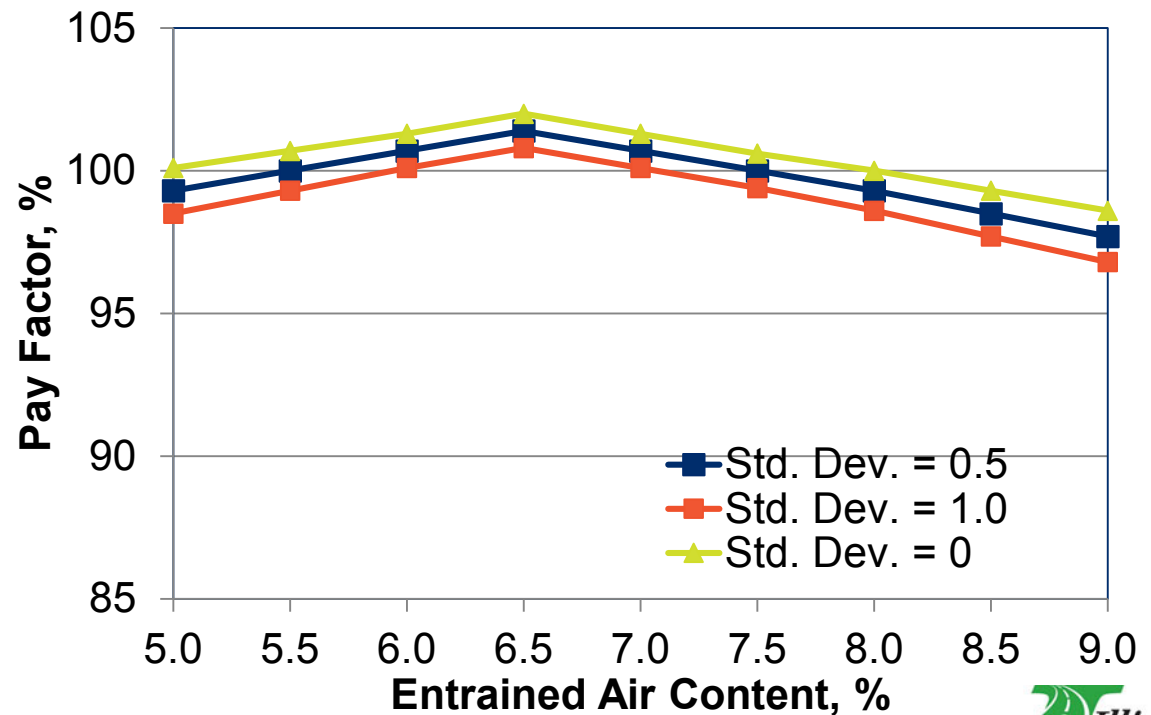
- Lot: All mainline concrete
- Sublot: Division of a lot for testing and sampling
 - One lane wide and ~1,000 ft. long
 - Provisions for pavement block-out
 - Access areas, bridge approach, ramp transition, etc.
- Sublot limits marked on plans (by lane)
- Payment is made on lot basis
- Rejection is made on sublot basis

Non-Conforming Materials

- If RQL not met, contractor to develop Corrective Action Plan
- No incentive/disincentive for a subplot with non-conforming materials.
- Accept or reject concrete on a subplot basis.

Air Content Quality Characteristic

- Test Data submitted through standard, materials information process
 - Air data collected onsite
 - Four tests per subplot; Average value reported for subplot
 - Pay Factor based on Mean and Standard Deviation of subplot values for Lot and interpolated based on the following table



Compressive Strength Quality Characteristic

- Test Data submitted through standard, materials information process
 - Two sets of two 6" x 12" cylinders cast at one of four air location
 - First two cylinders broken at 28-days
 - if less than 1,000 psi difference, use average of two values
 - If more than 1,000 psi difference, third cylinder is broken and two closest values (within 1,000 psi) are averaged
 - If none of first three are within 1,000 psi, fourth cylinder is broken, and two closest values are averaged
 - Average reported for sublots; Mean and Standard Deviation based on subplot values
 - Average strength adjusted for values greater than 6,500 psi

Issues Encountered or Lessons Learned

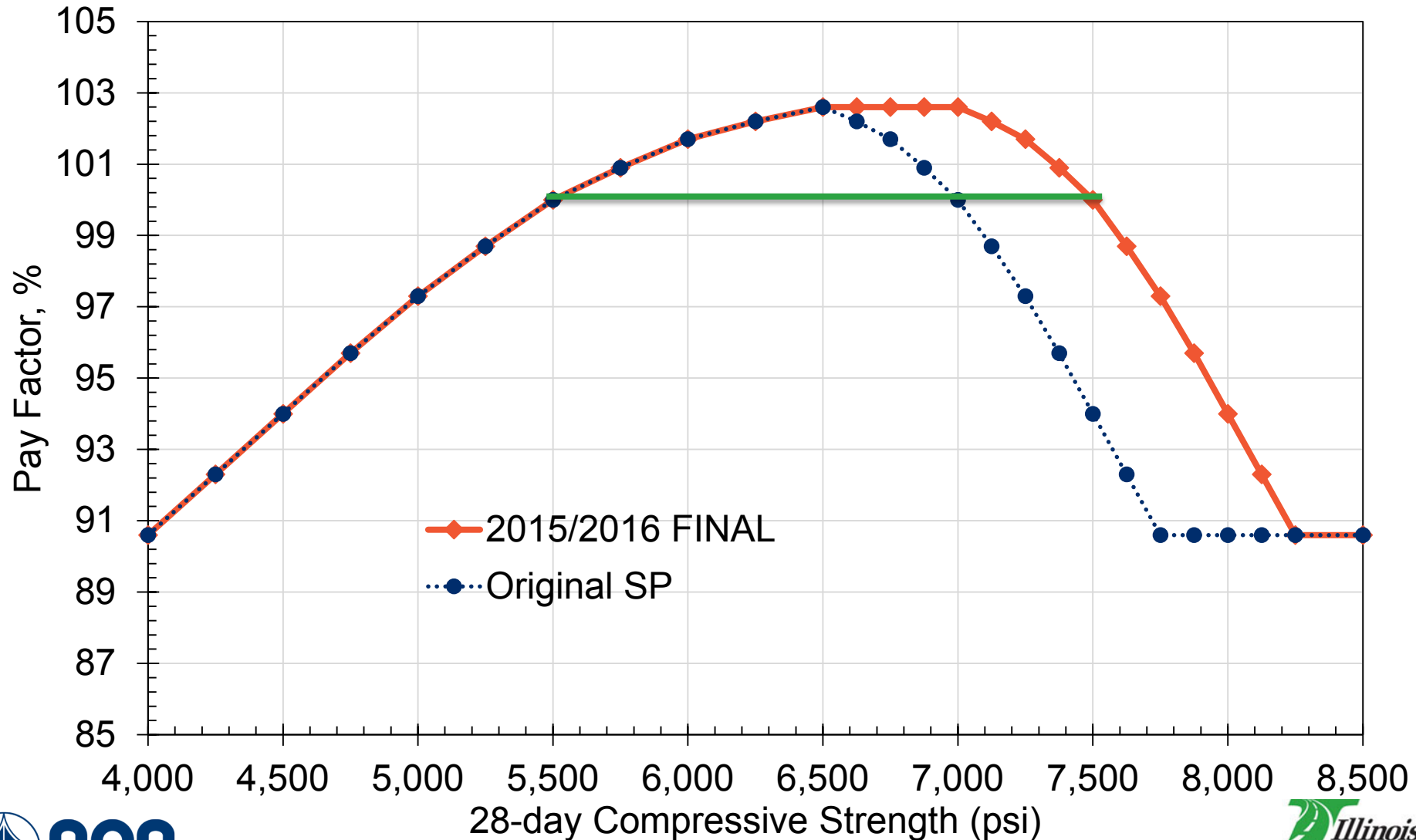
Mix Designs More Important

- 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



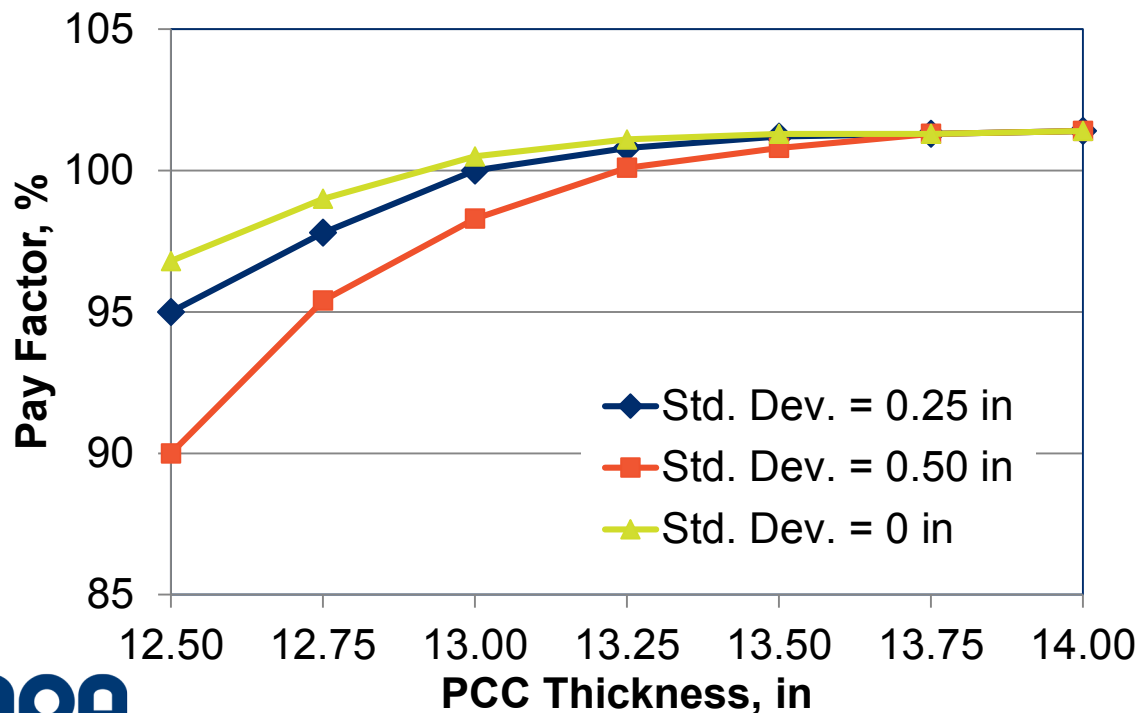
28-day Compressive Strength Adjustment



PCC Thickness Quality Characteristic

- Measured Using MIT T-2 Device

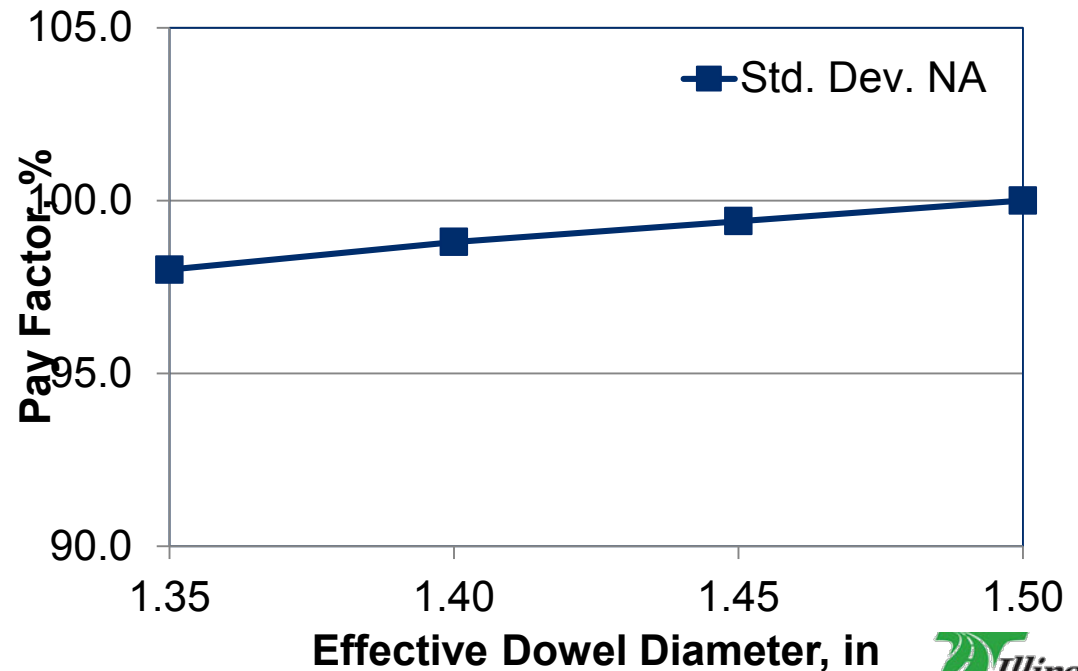
- Metal discs placed at randomly generated locations
- Six discs placed, only four thickness readings taken
- Average of four readings reported for each subplot
- Mean and Standard Deviation based on subplot values
- Measurements repeated if grinding performed



Courtesy: www.fhwa.dot.gov

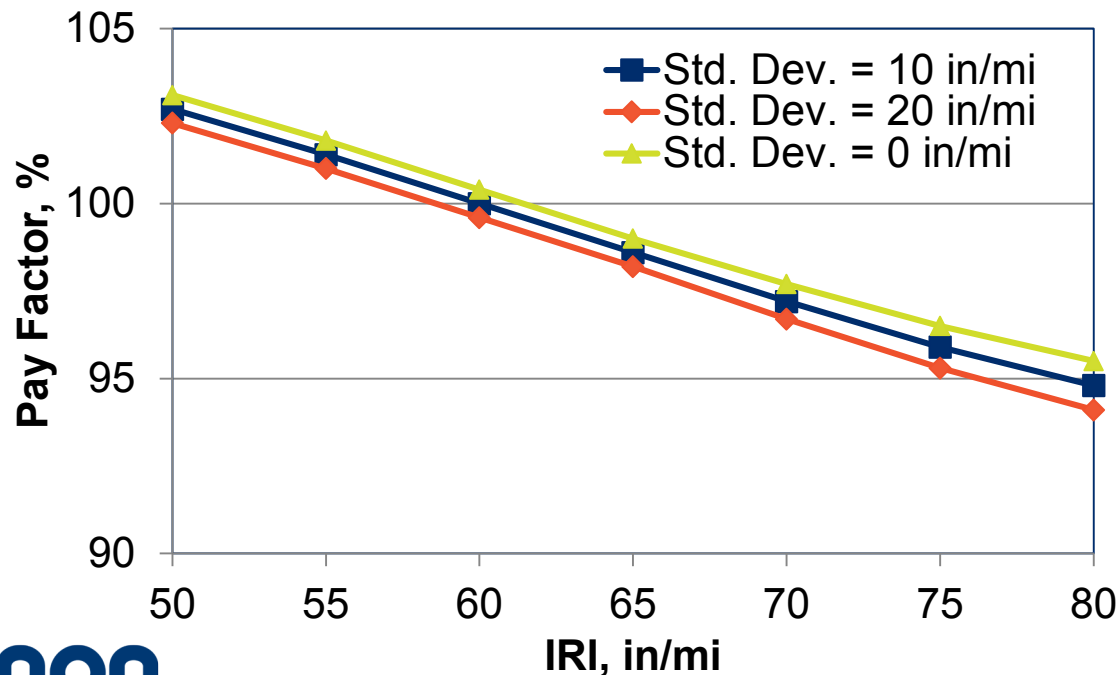
Dowel Bar Alignment Quality Characteristic

- 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 subplot
 - Mean and Standard Deviation based on subplot 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 subplot
 - IRI calculated for each WP
 - Average of two WP readings reported for each subplot
 - Mean and Standard Deviation based on subplot values



Spreadsheet to Track Construction Quality Data

- Will calculate pay factors even with partial 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.
DO NOT ENTER anything else or change anything else on this sheet.

Strength Pay Factor:	na
Thickness Pay Factor:	na
Dowel Diameter Pay Factor:	na
Air Content Pay Factor:	na
Smoothness Pay Factor:	na
Calculated Composite Pay Factor:	na
Adjusted Composite Pay Factor:	na
Enter Bid Price and Conforming Area below.	
BID PRICE (\$/sq. yd.):	
CONFORMING AREA (sq. yd.):	
Total Pay Adjustment (\$):	na

Data distributed to all through Ebuilder

Overall Pay Factor

- Overall PF Calculated for Sq. Yd. of PCC-PRS for each contract
 - Overall PF calculated by multiplying all five individual PF's together (Lot 1); only Air, Thickness, and Dowel Diam. PF's used for Lot 2
 - Divide result by 100⁴
 - Incentive capped at 5 percent (Maximum PF = 105)
 - Disincentive capped at 15 percent (Minimum PF = 85)

(Air) x (Strength) x (Thickness) x (Dowel Diam.) X (Smoothness)

$$\text{Lot 1} \quad \frac{101.2 \times 99.7 \times 101.1 \times 99.9 \times 100.5}{100 \times 100 \times 100 \times 100} = 102.41$$

(Air) x (Thickness) x (Dowel Diam.)

$$\text{Lot 2} \quad \frac{100.9 \times 100.5 \times 99.9}{100 \times 100} = 101.30$$

2015 Results

Lot 1

	A	B	C	D	E	F	G	H	I
Air Content	100.7	101.1	101.2	101.4	101.8	101.5	101.1	101.0	101.0
Strength	98.9	100.0	99.9	96.4	102.3	100.2	101.7	99.2	100.4
Thickness	101.2	101.3	101.1	101.0	100.7	100.1	101.1	100.9	100.8
Dowel Diam.	99.9	99.9	99.9	100.0	99.9	99.9	99.9	99.8	99.5
Smoothness	99.2	96.6	100.3	97.2	94.3	94.8	94.5	94.1	96.7
Composite PF	99.9	98.8	102.4	96.0	98.8	96.4	98.1	94.9	98.3

Lot 2

	A	B	C	D	E	F	G	H	I
Air Content		101.4	101.2	101.1	101.6	101.4	100.9	101.0	100.2
Thickness		101.0	100.9	101.0	100.9	100.5	100.5	101.0	100.0
Dowel Diam.		99.9	100.0	100.0	99.9	99.9	99.9	99.9	100.0
Composite PF		102.3	102.1	102.1	102.4	101.8	101.3	101.9	100.2

Contract PF	99.9%	99.4%	102.3%	100.9%	100.3%	99.4%	99.1%	95.2%	98.4%
Overall 2015 Construction Estimate									100.2%

Year over year quality improvement

2015 Composite Results

	A	B	C	D	E	F	G	H	I
Contract PF	99.9%	99.4%	102.3%	100.9%	100.3%	99.4%	99.1%	95.2%	98.4%
Overall 2015 Construction Estimate									100.2%

2016 Preliminary Results

	A	B	C	D	E	F	G
Air Content	100.9	101.1	101.0	101.2	101.1	100.6	101.4
Strength	98.6	101.1	101.4	100	101.4	101.7	101.9
Thickness	100.4	101.1	101.0	101.1	100.7	101.0	101.2
Dowel Diam.	99.9	100.0	100.0	99.9	99.8	99.9	99.9
Smoothness	96.3	99.2	100	95.9	97.4	97.2	97.3
Composite PF	96.1	102.5	103.4	98.0	100.3	100.3	101.6

Overall 2015 Construction Estimate	101.2%
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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

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





Thank
You