

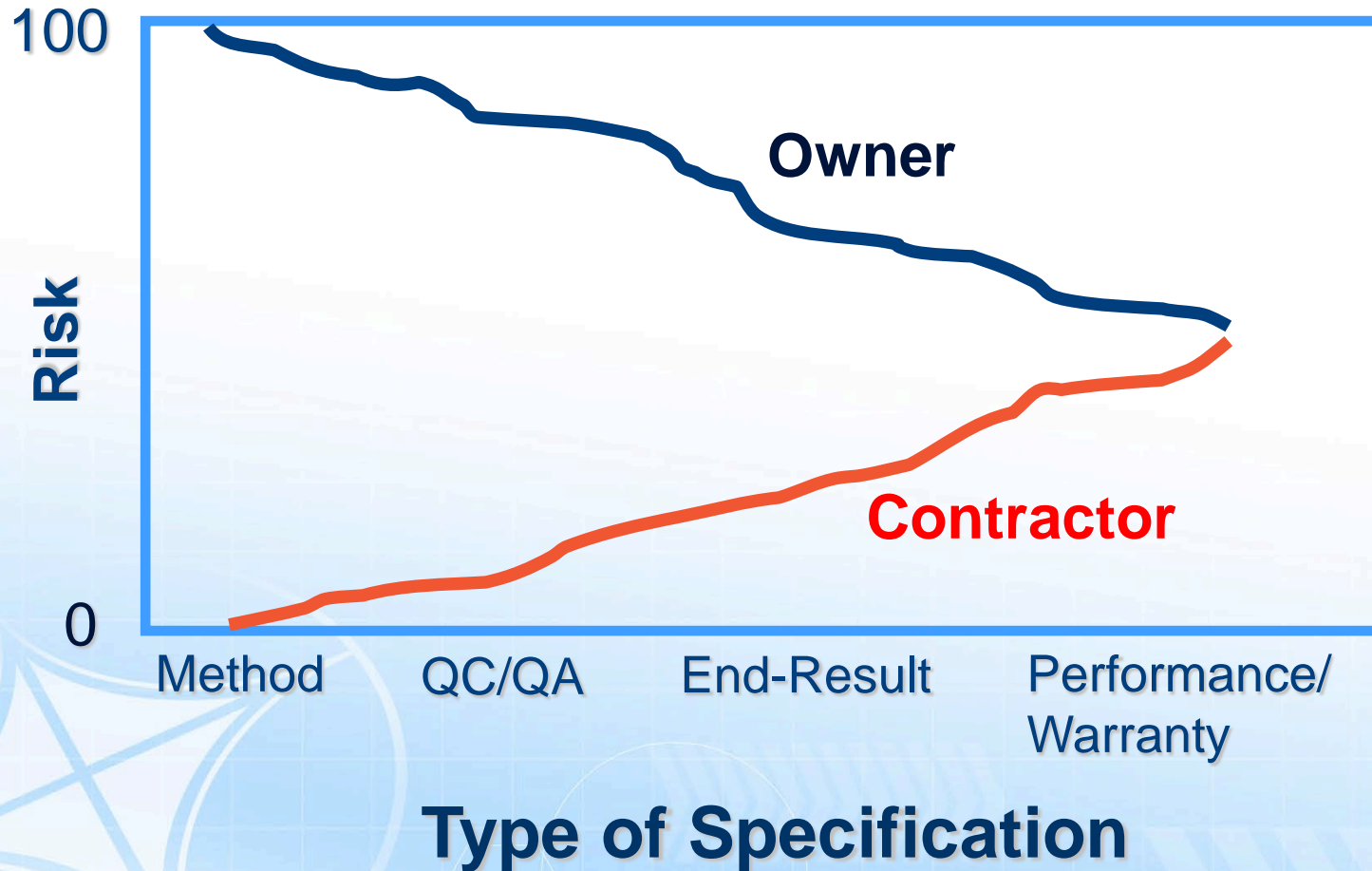
# Performance Related Specifications for Concrete

101<sup>st</sup> Annual Transportation Highway Engineering Conference

24 Feb 15

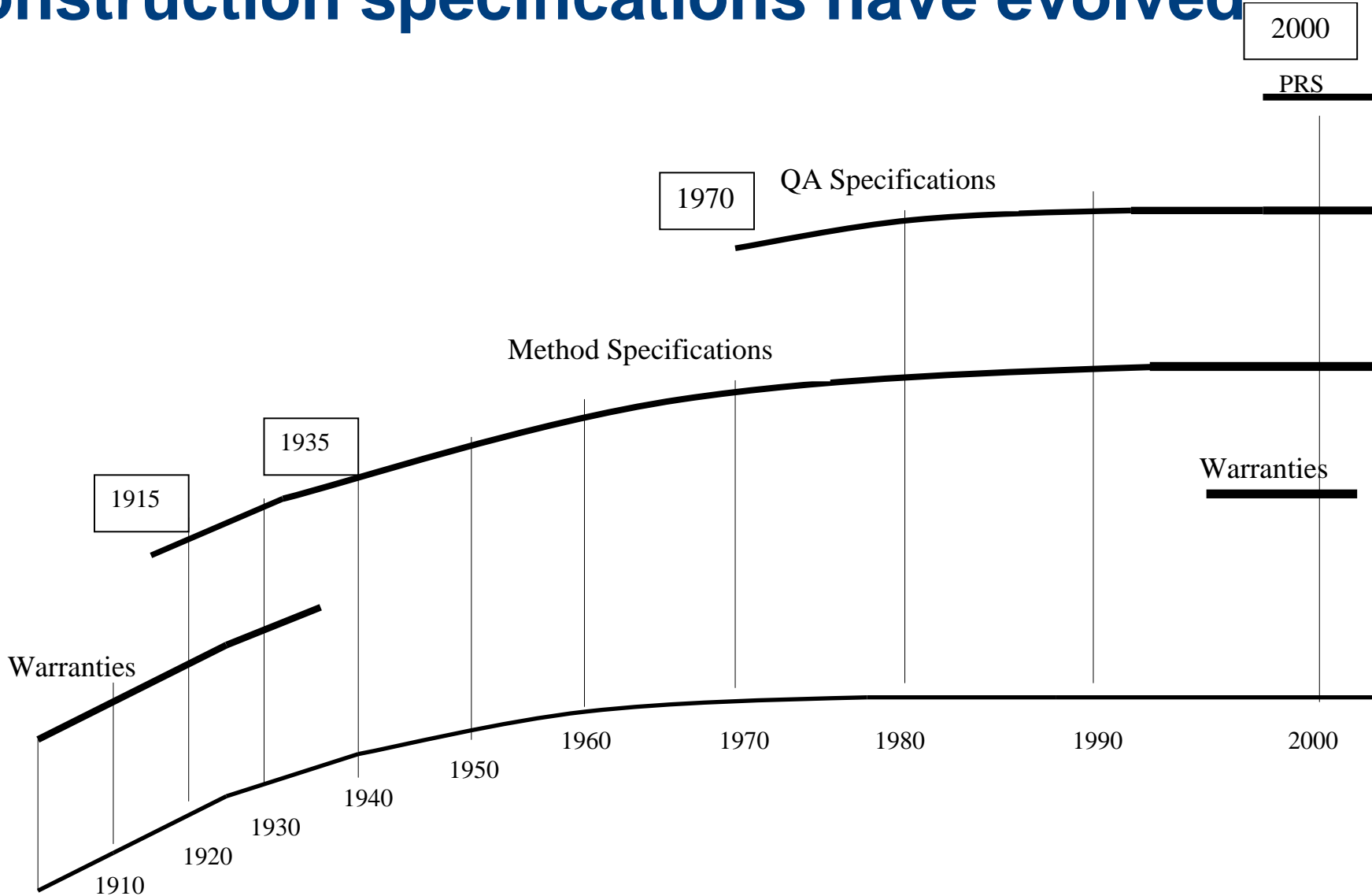


# Specifications have different risk profiles



**Type of Specification**

# Construction specifications have evolved



Pavement Design

# How PRS Works

PAVESPEC

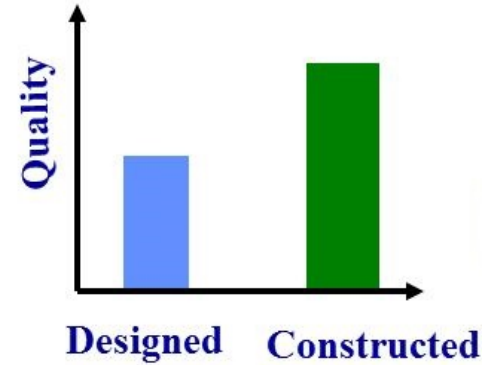
Planning



Establish Performance Criteria



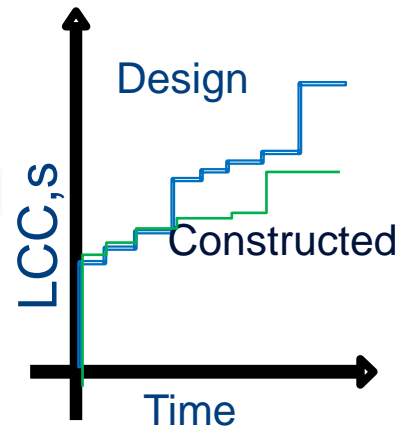
Identify AQC's and Target Values



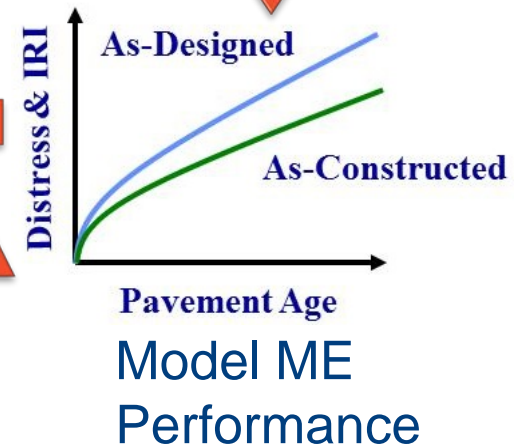
Design AQC vs. As-Constructed AQC



Pay Factor  $f(\Delta LCC)$

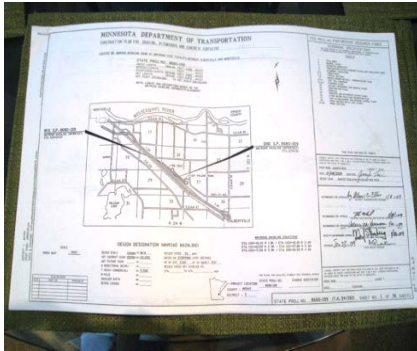


Compare As-Built and As-Designed



M&R Plan

## Use Specifications



Incorporate Pay Tables  
Into Specifications &  
Project Letting



Pavement Construction,  
Sampling, and Testing



Incentive and  
Disincentive Pay



# PRS applied to larger paving projects

Project would have at least 10 sublots

Will be evaluated and determined by Tollway

Pay factors will be different by corridor



# Pavement type selection report is the PRS basis

Traffic

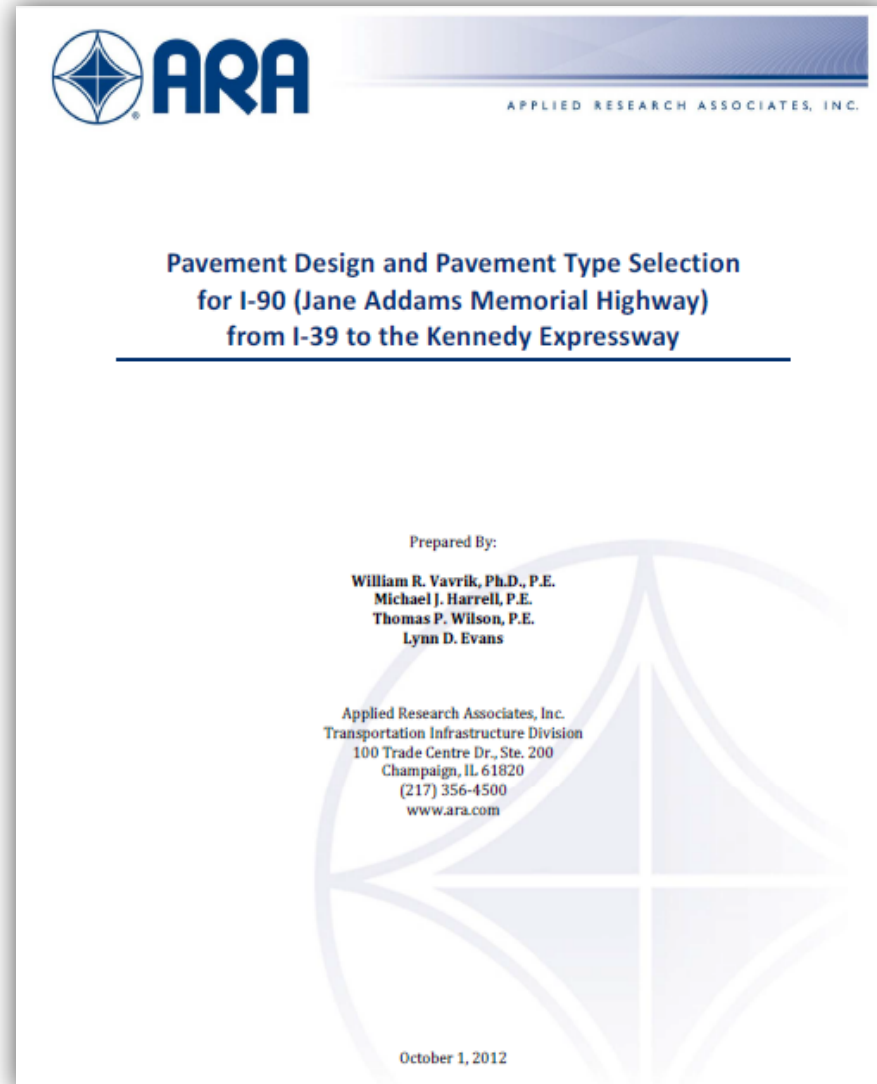
Design

Reliability & Performance Criteria

Support conditions

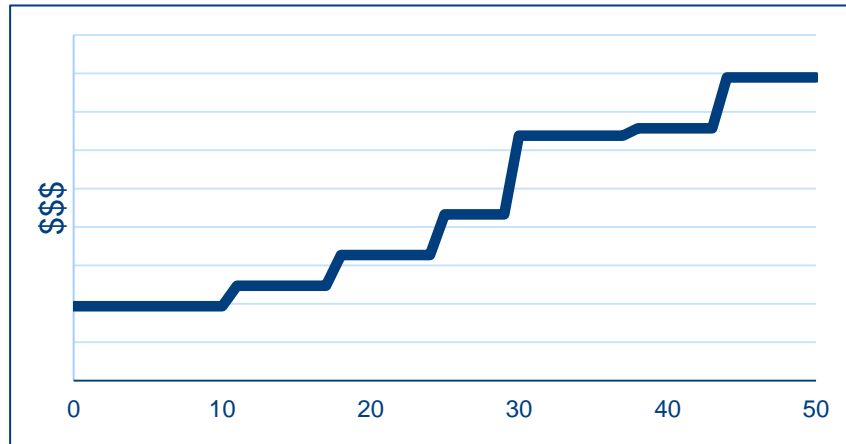
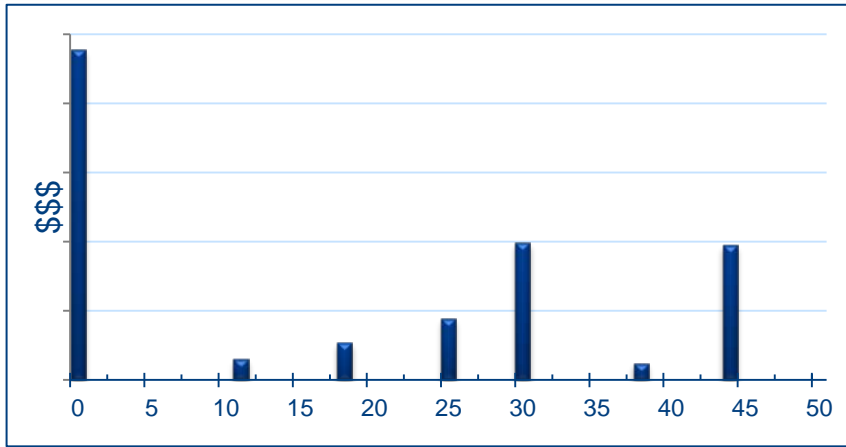
M & R strategies

Costs & other miscellaneous data

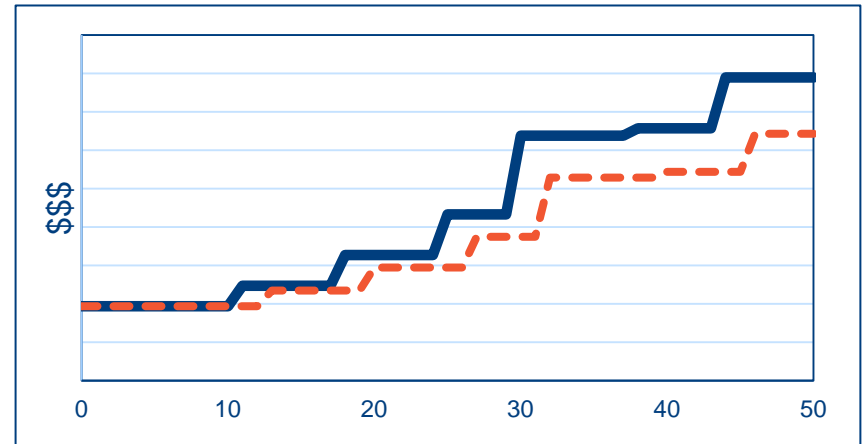
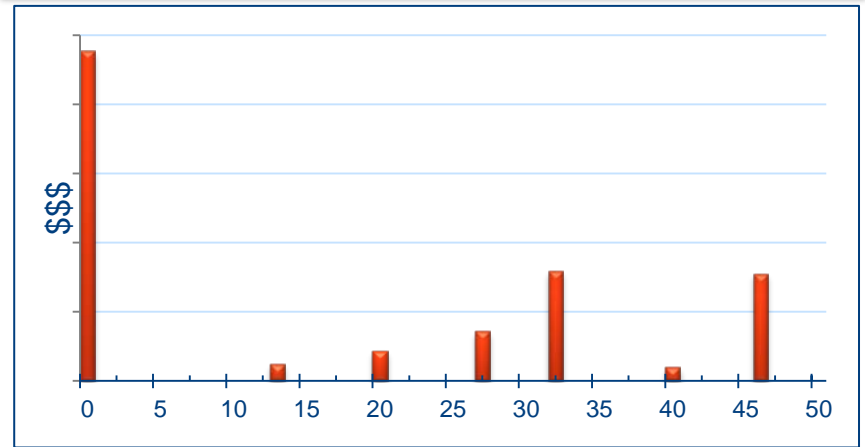


# Pavement Life Cycle Cost Model

Design Life Cycle Cost



As-Built Life Cycle Cost





# First define Acceptance Quality Characteristics

## Measurable

- 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**

# Levels of Pavement Quality

## Target Quality Level (TQL)

- At target 100% pay
- Near target pay adjustment (incentive/disincentive)

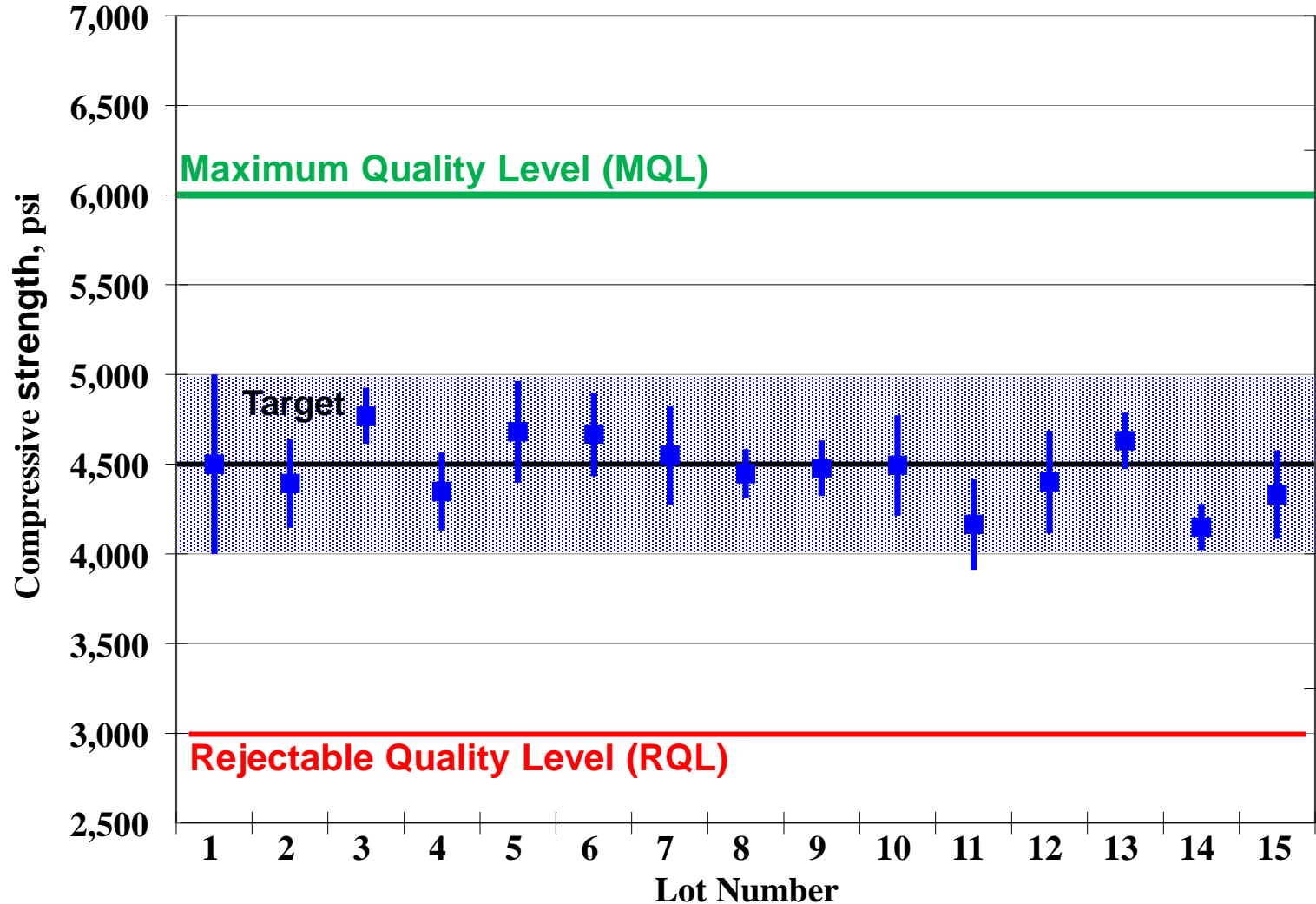
## Rejectable Quality Level (RQL)

- Corrective measures required

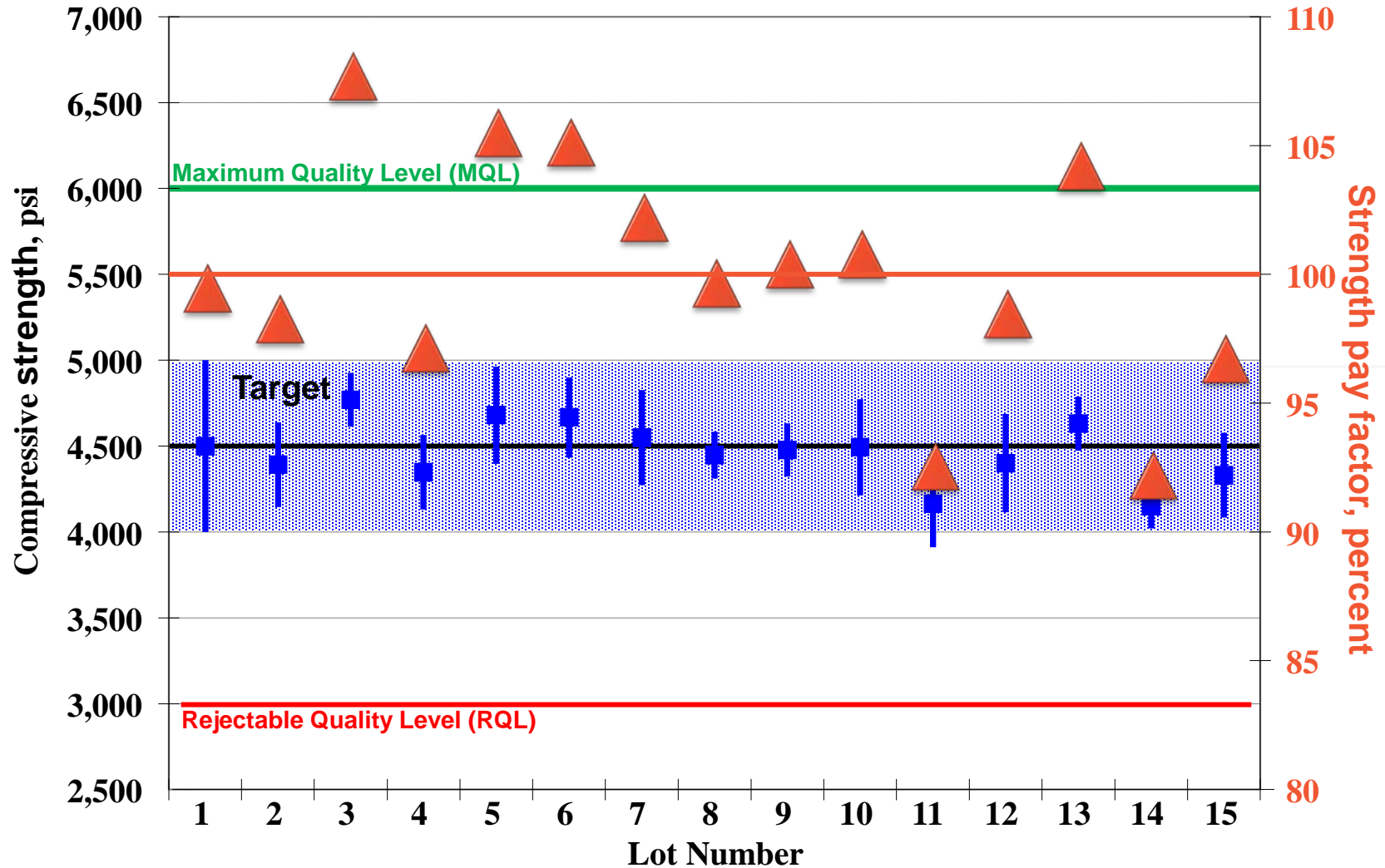
## Maximum Quality Level (MQL)

- No further incentive

# Examples of Important Definitions



# Examples of Important Definitions



# 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 sublot basis**



# Random sampling is a key requirement

Every subplot has equal weight

Random number generator to determine sample location

Random locations determined before each paving day

# Non-conforming Materials - revised

**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.**

# 28-Day Compressive Strength

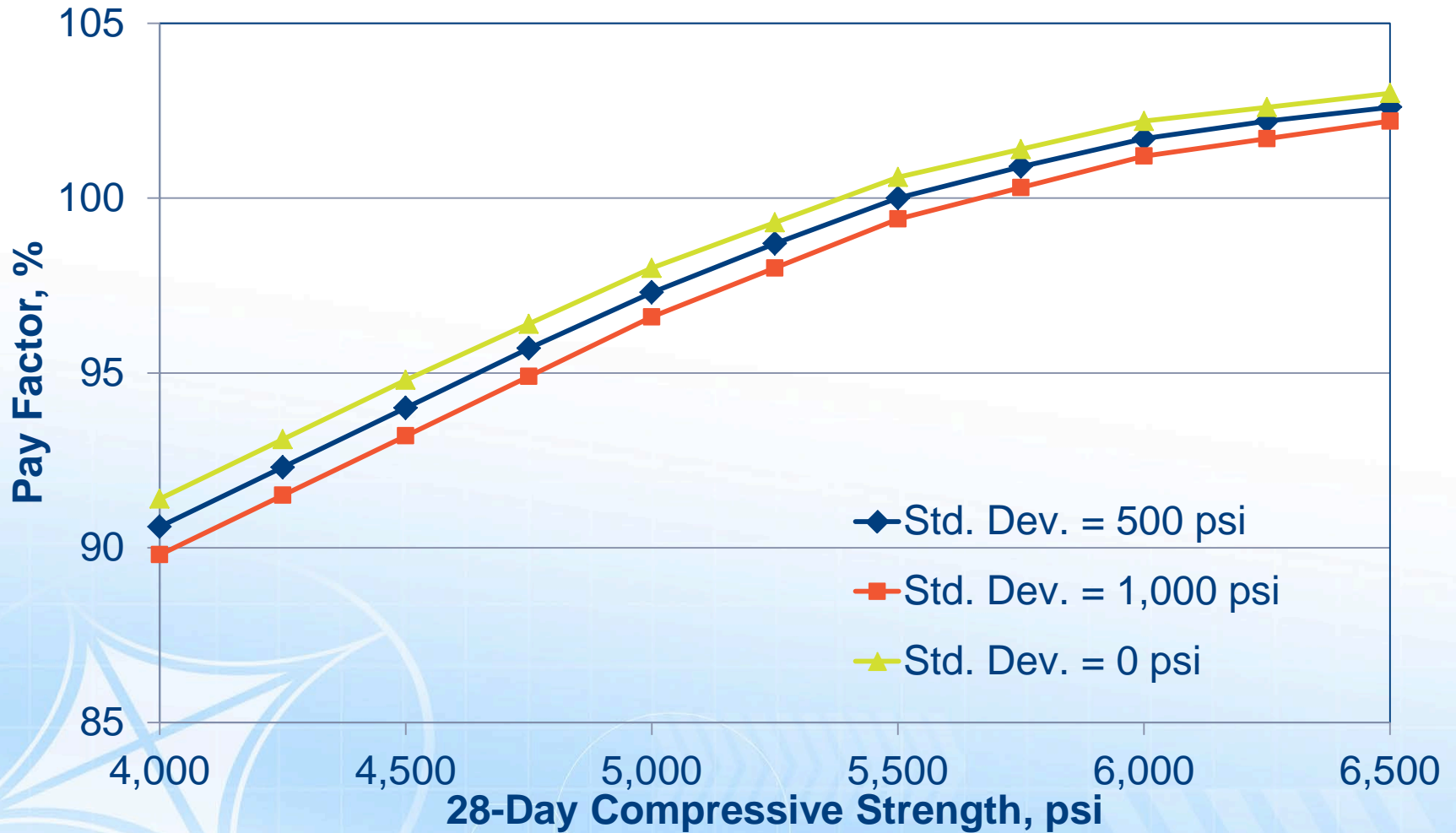
## Test with cylinders (Illinois Modified AASHTO T22, T23)

- Process described in IDOT Article 1020.09 Strength Tests
- 6"x12" cylinders only

## Two cylinders per subplot

Level	Mean (psi)	Std. Dev. (psi)
Target	5,500	500
Rejectable	4,000	-
Maximum	6,500	-

# Strength pay factor curve



# Air Content

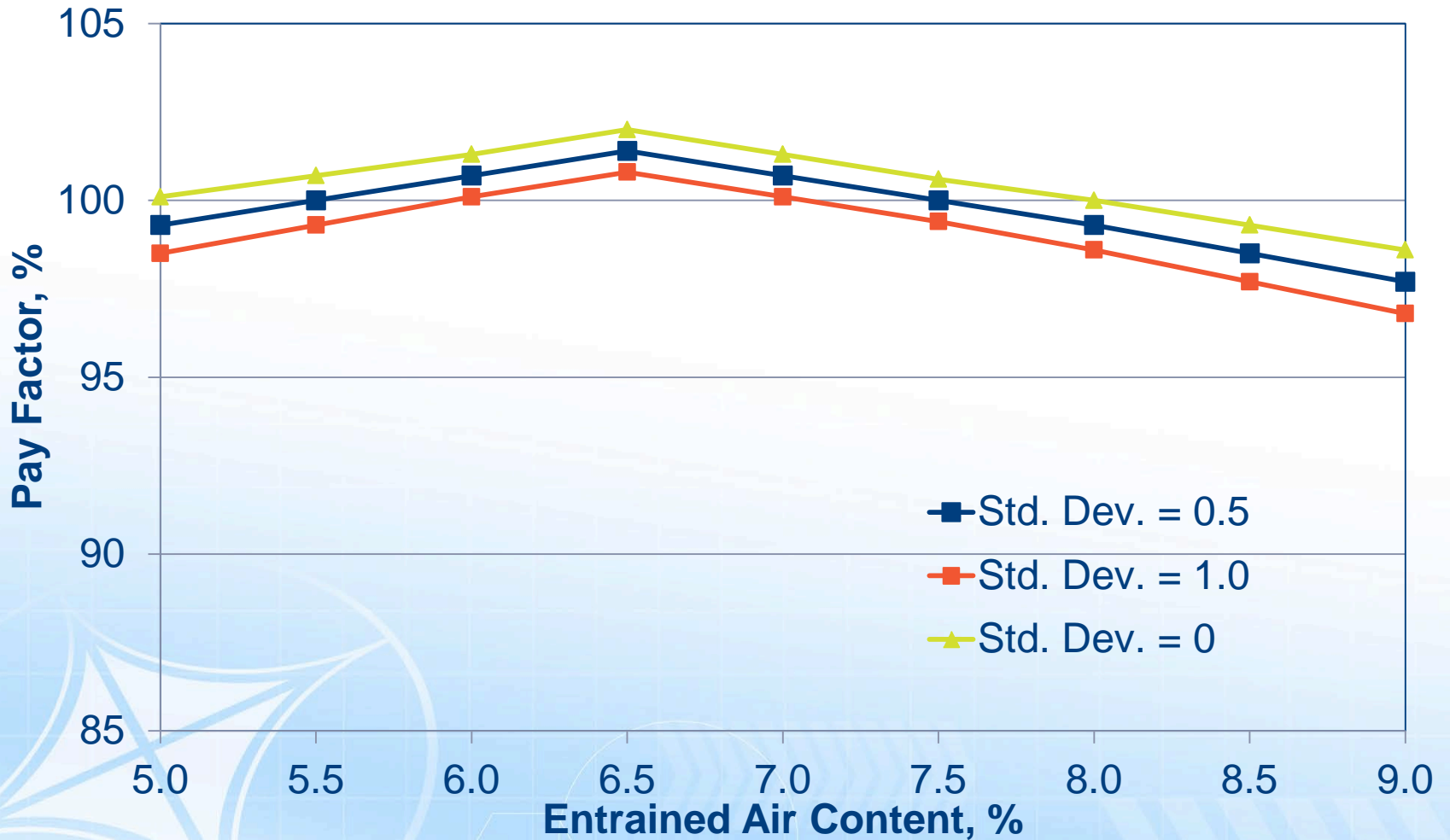
## Test with pressure meter according to IDOT Article 1020.08 Air Content

### Computed from average of four tests per sublot

- Same samples used for strength cylinders + 3 others

Level	Mean Content (%)	Standard Deviation (%)
Target	6.5	0.5
Rejectable	5.0	-
Maximum	9.0	-

# Air content pay factor curve





# Slab Thickness

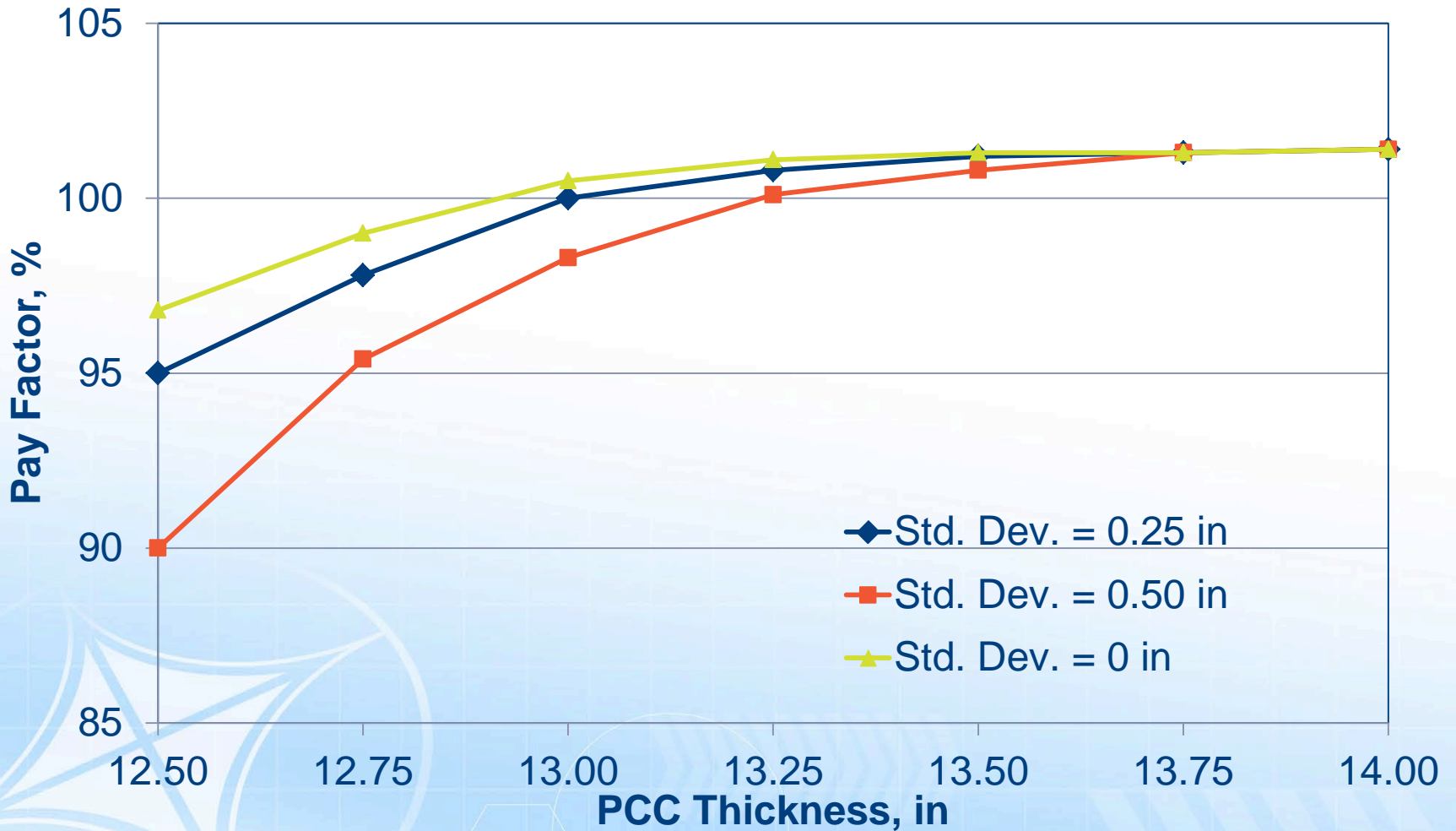
**Test with MIT-Scan T2 meter as described by user manual**

- Random pre-determined locations

**Computed from average of four measurements per subplot**

Level	Mean (in.)	Std. Dev. (in)
Target	Plan thickness	0.25
Rejectable	Plan thickness - 0.5	-
Maximum	Plan thickness + 1.0	-

# Slab thickness pay factor curve



# Smoothness (IRI)

## Test in accordance with ASTM E950

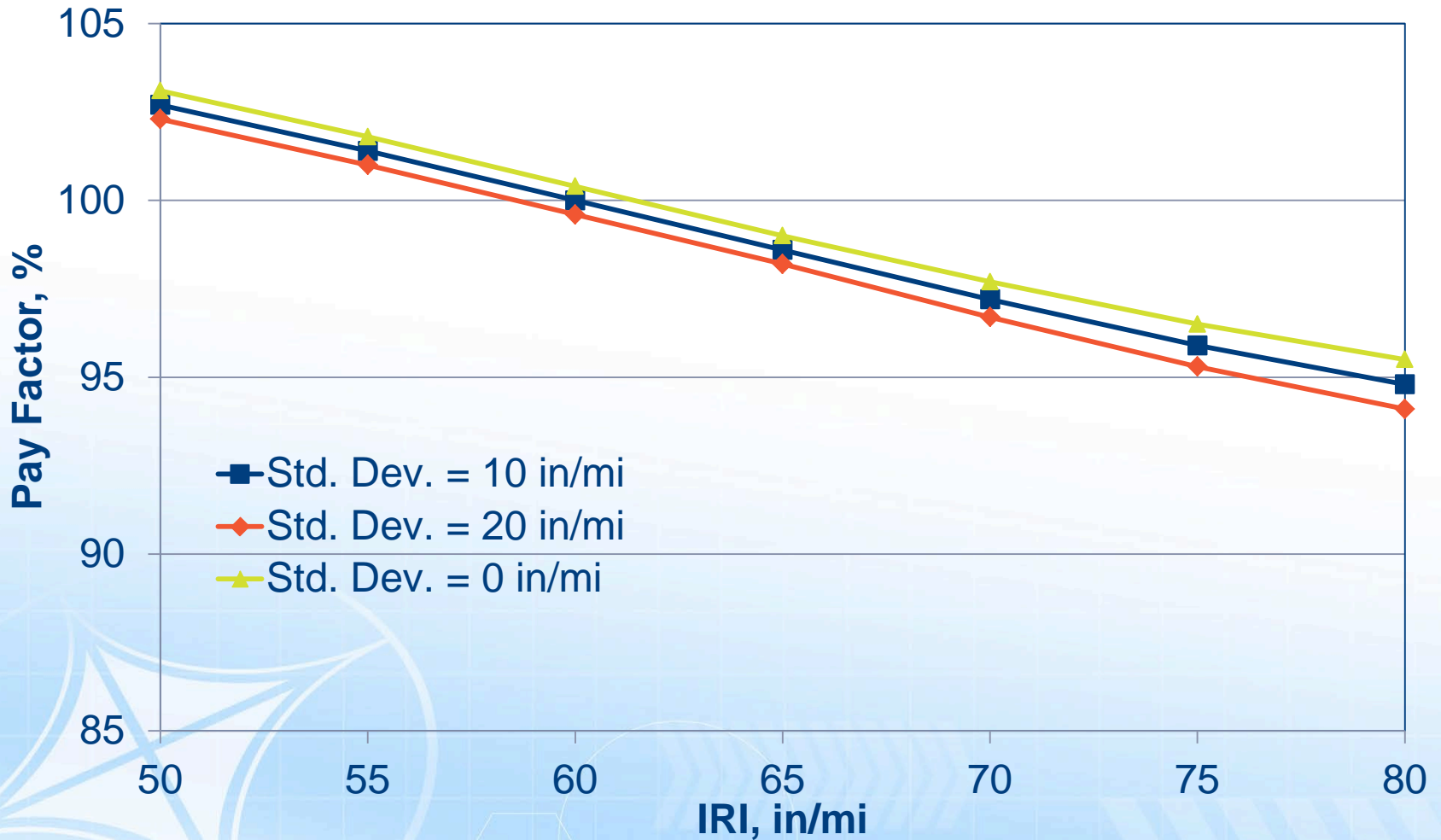
- Class I inertial profiler

## Test and report each wheel path

## Computed from average of wheel paths

Level	Mean (in./mile)	Std. Dev. (in./mile)
Target	60.0	10.0
Rejectable	80.0	-
Maximum	50.0	-

# Smoothness pay factor curve



# Effective Dowel Diameter (EDD)

Test with MIT-Scan 2

Calculate EDD as described in NCHRP Report 637

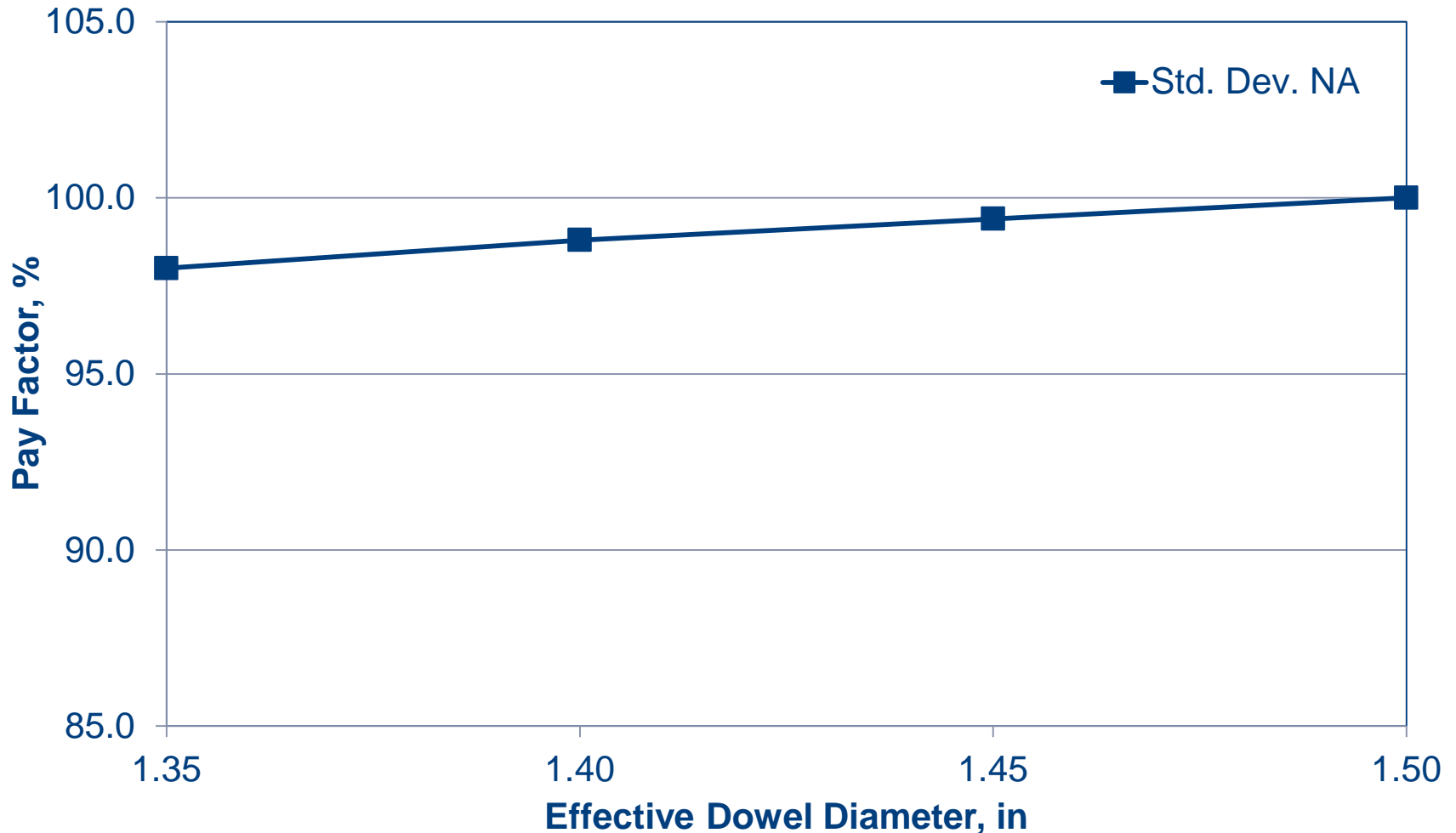
Averages of five consecutive joints

Rejection on individual alignment criteria

Process control separate of PRS

Level	Mean (in.)	Std. Dev. (in.)
Target	1.50	N/A

# Effective dowel diameter pay factor curve





# PRS Example Project

3 random Lots selected

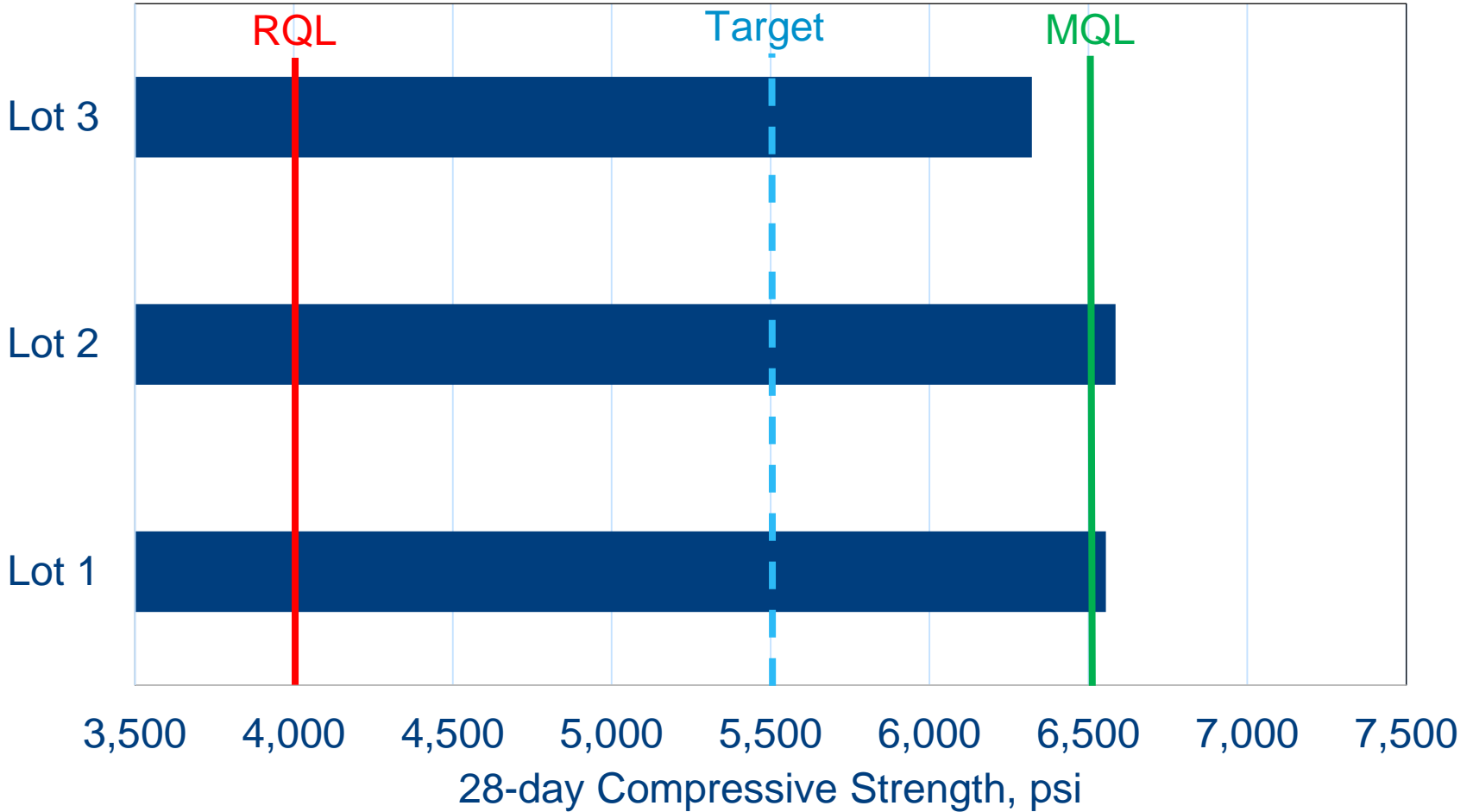
## Tested For

- 28 Day Compressive Strength
- Slab Thickness
- Air Content
- Smoothness
- Effective Dowel Diameter

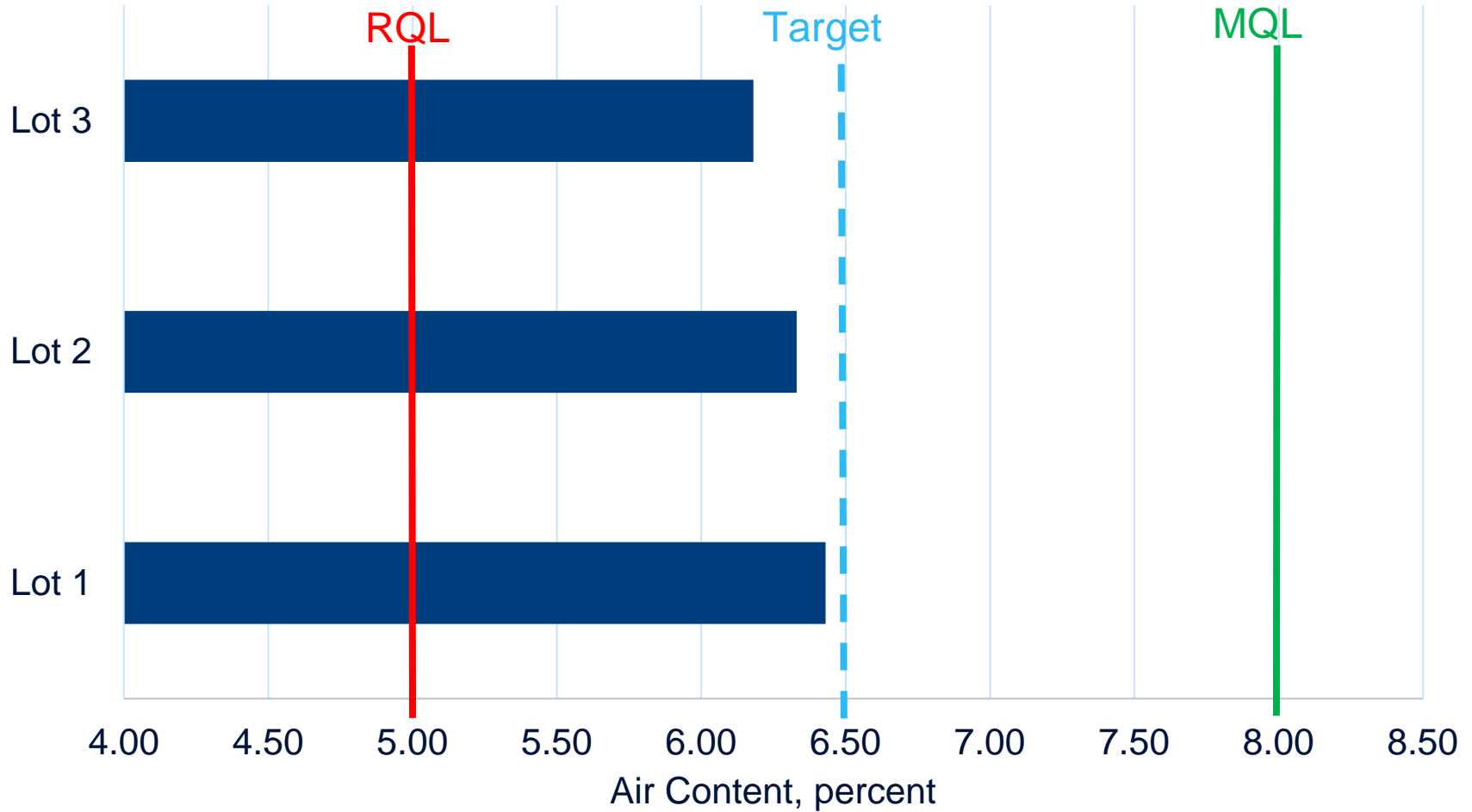
Individual and Composite Pay Factors (PF) calculated



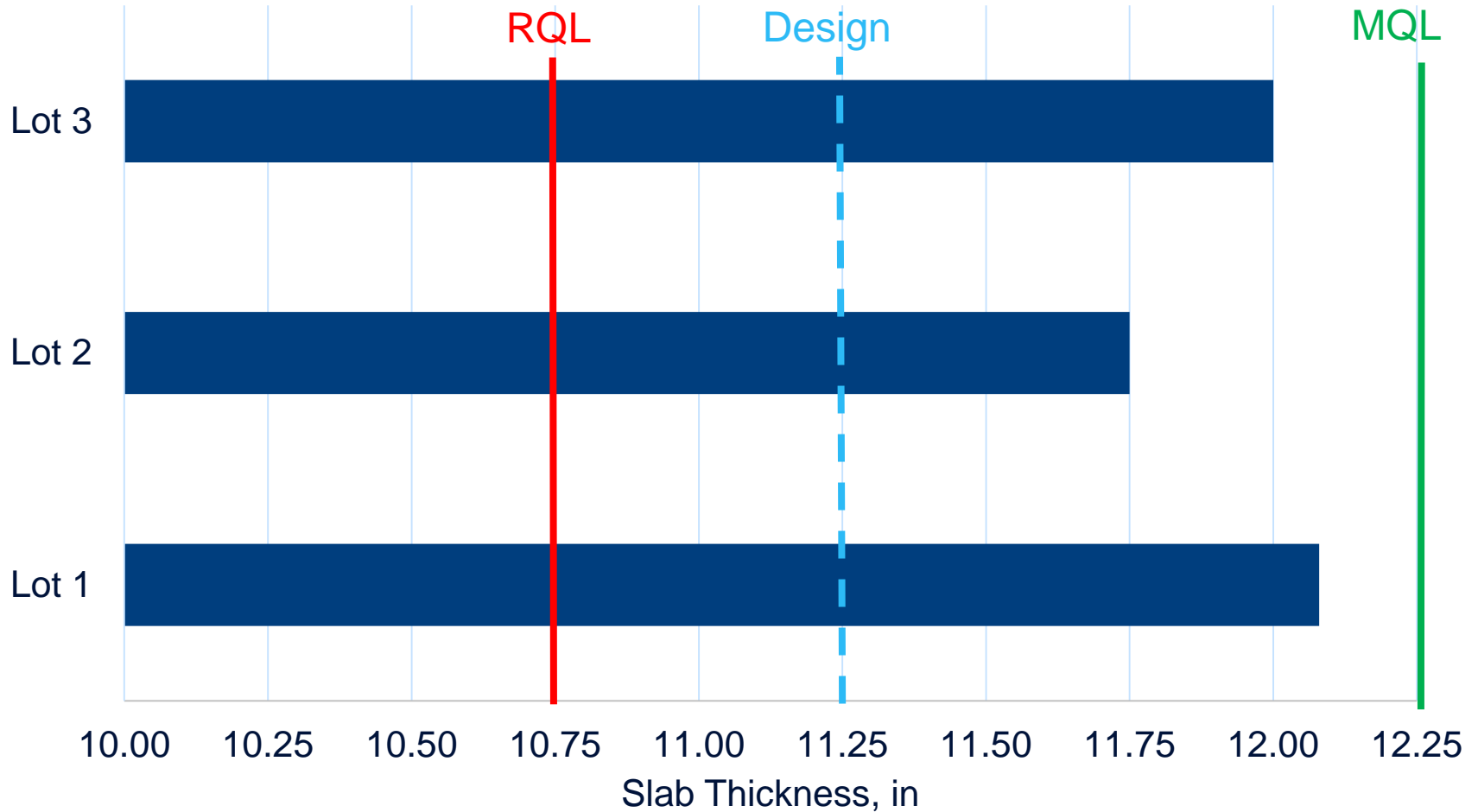
# 28-day Compressive Strength - Proposed



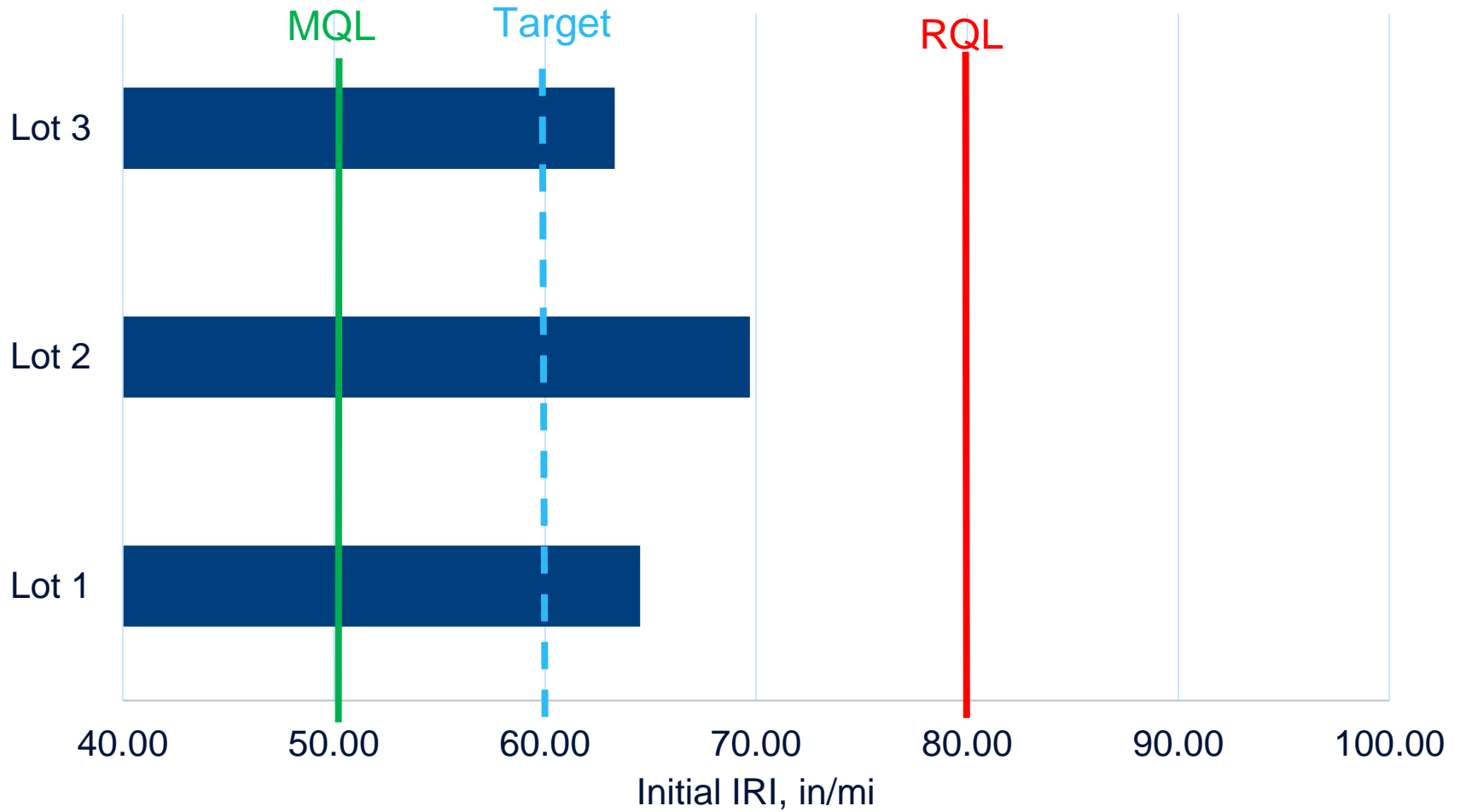
# Air content example



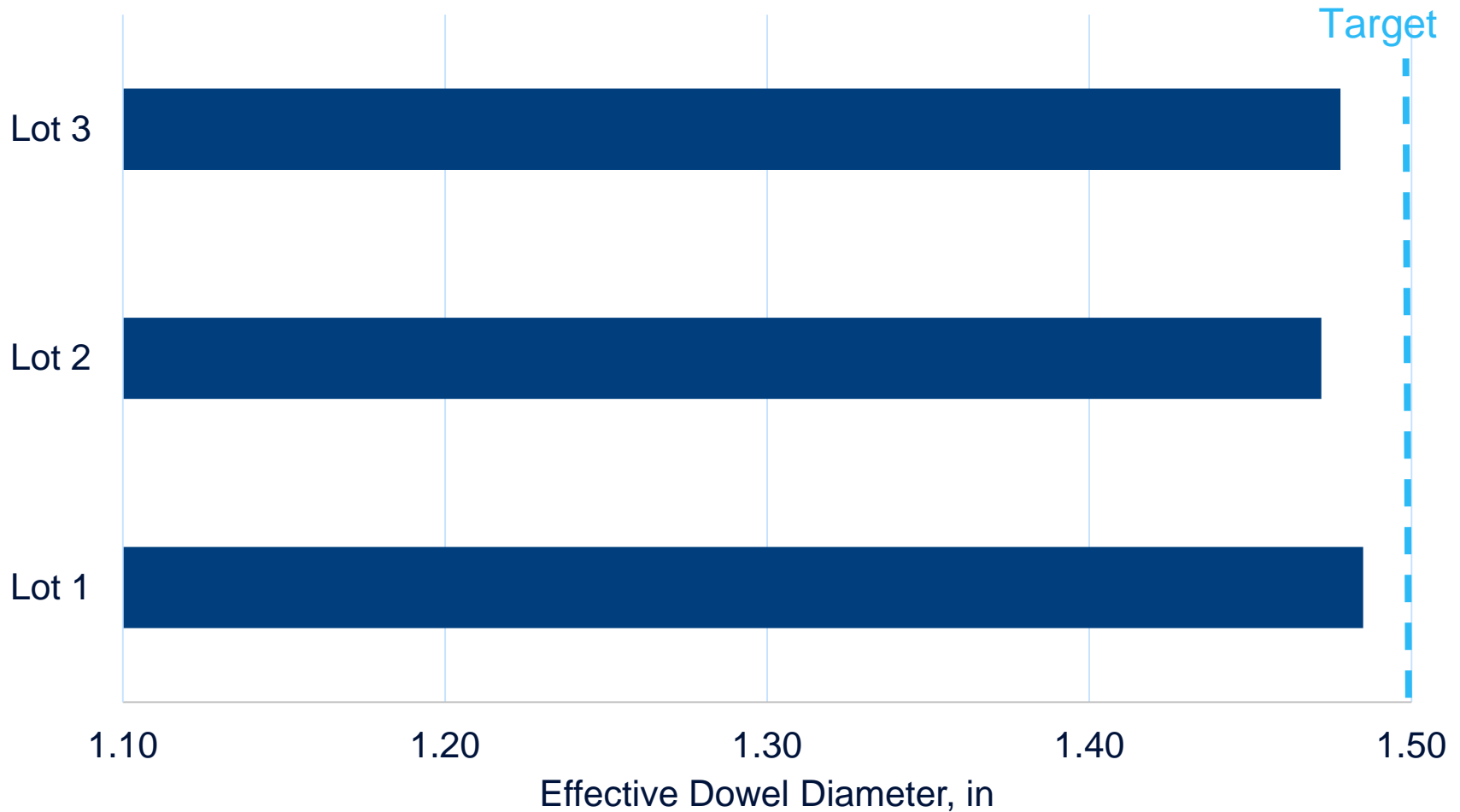
# Slab thickness example



# Smoothness example



# Effective dowel diameter example



# Lot Composite Pay Factors

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

*Maximum Composite PF: 105%*

*Minimum Composite PF: 85%\**

*\*Provided AQC's meet the RQL standards*

# PRS Evaluation for 2013 projects

## Using Example PRS

- Maximum pay – 105.3%
- Minimum pay 93.3%
- Average pay – 99%

**We are achieving this quality level with current practice!**





# Spreadsheet to track PRS 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
<b>Enter Bid Price and Conforming Area below:</b>	
BID PRICE (\$/sq. yd.):	
CONFORMING AREA (sq. yd.):	
Total Pay Adjustment (\$):	na

# Performance-Related Specifications (PRS) benefit Tollway, consultants, and contractors

Pavement design basis for construction  
performance

Incentives and disincentives based on LCCA

Contractors can innovative be competitive

No long-term monitoring and management

Testing focuses on key characteristics

- Measureable
- Related to performance

# Thank You



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