Quality Systems for Concrete Pavement

10th Annual Pennsylvania Concrete Conference
American Concrete Pavement Association (ACPA)-Pennsylvania Chapter

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Acknowledgment

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Objectives

- Assess and summarize current forms of performance specifications:
  - Performance-related specifications (PRS)
  - Warranty specifications
- Investigate ways for improving these specifications

Where are we and how do we move forward with performance specifications?

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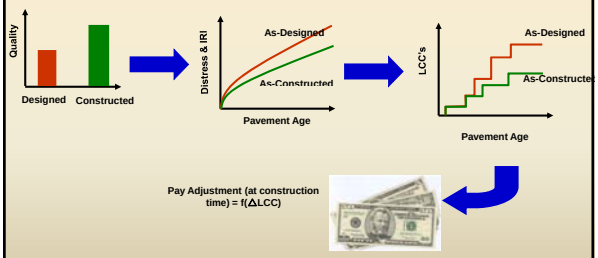
Performance-related Specifications



Pay Adjustment (at construction time) = f(ΔLCC)

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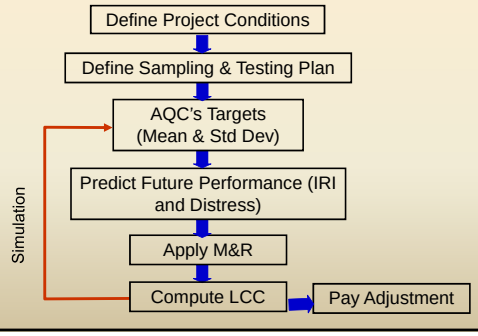
Development of Performance-related Specifications



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Pay Adjustment Computation

As-Designed Pavement	As-Constructed Pavement
AQC Target Means & Stand. Deviations	AQC Measured Means & Stand. Deviations
Distress & IRI Models	Distress & IRI Models
As-Designed Present Worth LCC	As-Constructed Present Worth LCC

Pay Adjustment

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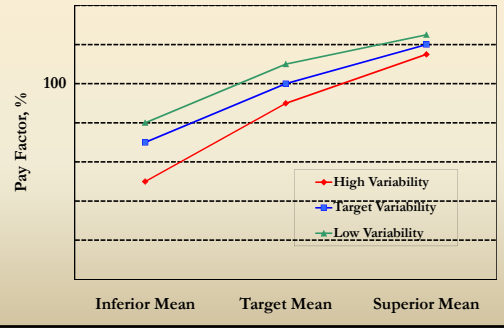
Typical Trend of Pay Factor (PF) Curves



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Acceptance Quality Characteristics (AQCs)

PRS specifying the target mean and variability levels of AQC's that:

- Are measurable
- Have been found to correlate with performance
- Are under the contractor's control

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Concrete Pavement AQCs

- Concrete strength (compressive or flexural)
- Slab thickness
- Air content
- Consolidation around dowel bars

- Initial smoothness [International Roughness Index (IRI) or Profile Index]

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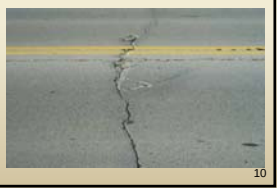
Concrete Pavement Performance Indicators

Predicted future performance:

- IRI
- Transverse cracking
- Joint faulting
- Joint spalling



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PRS Concrete Pavement Projects

- Indiana 2000, 2001, 2002
- California 2003 (not constructed)
- Florida 2003-04
- Tennessee 2004
- Wisconsin 2006

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Florida PRS Concrete Pavement Project

- Part of the I295/I-95 Interchange project in Jacksonville, Florida
- About 0.5 centerline miles of JPCP, 3 lanes in each direction

Florida PRS: AQC Targets

AQC	Target Mean	Target StdDev
Slab Thickness, in	12.5	0.5(1)
PCC 28-day Comp. Strength, psi	4,500	610(2)
Initial Profile Index, in/mi	3.0	1.0(3)

(1) n = 2 per sublot, m = 1
(2) n = 1 per sublot, m = 2
(3) n = 1 per 0.1 mile, m = 2 per lane

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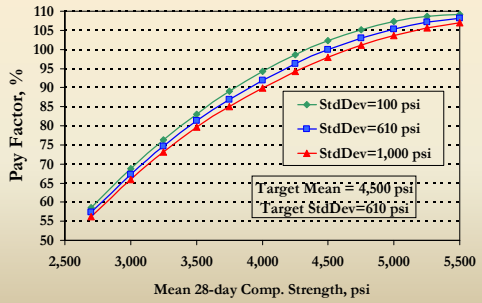
Florida PRS: Strength PF Curve



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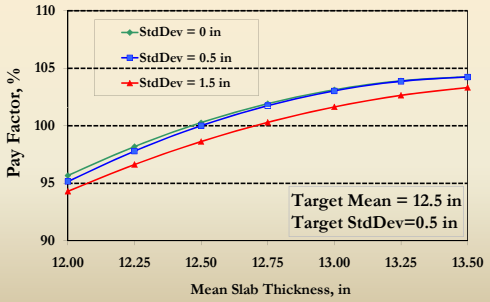
Florida PRS: Slab Thickness PF Curve



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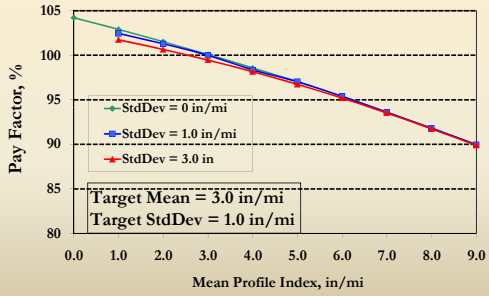
Florida PRS: Smoothness PF Curve



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Florida PRS: Final Composite PF

- Composite PF = PF_{str}* PF_{thk} * PF_{smth}
- Maximum Composite PF: 110%
- Minimum Composite PF: 90 %
- Actual PF: 110% (10% incentive over bid price).

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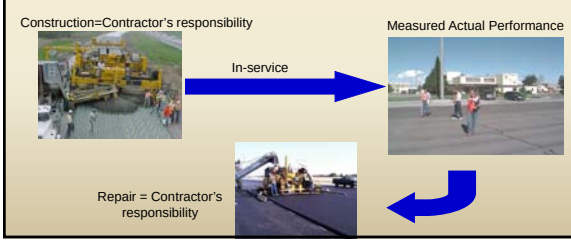
Warranty Specifications

A type of performance specifications that guarantees the integrity of a product and assigns responsibility for the repair or replacement of defects to the contractor.



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Warranty Types – by Coverage

Attribute	Materials and Workmanship	Partial Performance	Performance
Covers Design-Related Distresses/Defects	No	Some	Yes
Covers Materials and Workmanship-Related Distresses/Defects	Yes	Yes	Yes
Design Responsibility	SHA	SHA & Contractor	Contractor

SHA: State Highway Agency

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Types of Warranties – by Project Delivery Method

- Design-Bid-Build-Warrant
- Design-Build-Warrant

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Warranty Practices – Example States (Design-Bid-Build-Warrant)

State / Attribute	Wisconsin	Indiana	Illinois	Michigan	Florida
Approx. No. of Projects	123 (as of 2006)	13 (as of 2003)	27 (as of 2004)	213+ (as of 2005)	530 (as of 2007)
Pavement Type Selection	SHA	SHA	SHA	SHA	SHA
Design Responsibility	SHA: Thickness & Base Contractor: Mix and Materials	SHA: Thickness & Base Contractor: Mix and Materials	SHA	SHA	SHA
Warranty Period, year	PCC: 5 HMA: 5	PCC: 5-10 HMA: 5	PCC: 5 HMA: 5	PCC: 5 HMA: 5	PCC: 5 HMA: 3-5
Corrective Action Selection	Prescribed	Minimum Requirements Prescribed	Prescribed	Recommended	Prescribed
Basis for Performance Thresholds	Met by 90% of existing 5-yr old pavements	PMS data	Met by 95% of existing 5-yr old pavements	PMS data and "cross-table" negotiations	Met by 95% of existing 3- to 5-yr old pavements
Evaluation Section	2 0.1-mi sections per mile	Varies by Performance Indicator	0.1 mi	0.1 lane-mile	0.1 lane-mile
Performance Monitoring	Bi-annually, by SHA	Interstate: Annually Non-Interstate: Bi-annually by SHA	Annually, by SHA	As needed, by SHA	Annually, by SHA
Conflict Resolution Team	2 contractor reps, 2 WDOT reps, & 1 mutual rep	2 contractor reps, 2 INDOT reps, & 1 mutual rep	1 contractor rep, 1 IDOT rep, & 1 mutual rep	2 contractor reps, 2 MDOT reps, & 1 mutual rep	Statewide Disputes Review Board (1, 1, 1)
Warranty Bond	PCC: % of contract amount HMA: Cost for 11/2" overlay	PCC: 20-40% of bid price HMA: Surface replacement cost	20-50% of bid price	$1M or 5% of total contract amount, whichever is less.	Guarantee (no bond required)

Concrete Pavement Performance Indicators

State / Perf. Indicator	Wisconsin	Indiana	Illinois	Michigan	Florida
CRCP Punchouts	NA	NA	Yes	NA	NA
Cracking	Yes	Yes	Yes	Yes	Yes
Spalling &/or Joint Sealant Failure	Yes	Yes	Yes	Yes	Yes
Scaling	No	Yes	Yes	Yes	No
Patching	Yes	No	Yes	No	No
Edge Drop-off	No	No	No	No	No
Faulting	Yes	No	No	No	No
Ride	No	Yes	Yes	No	Yes
Skid Resistance	No	Yes	No	No	No
Distress Score/Index	No	No	No	No	No

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To achieve objective, data-driven performance specifications, design, construction, and performance data need to be linked.

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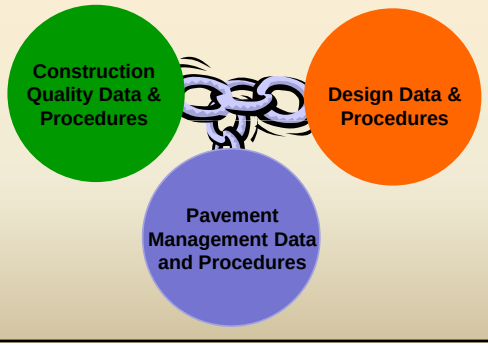
Advanced Quality Systems (AQSs)



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Key Aspect of an AQS

- Address quality throughout the product's lifecycle
- Provide feedback for continuous improvement
- Comprehensive database that can serve the needs of different applications:
  - Design
  - Construction quality
  - Maintenance and rehabilitation

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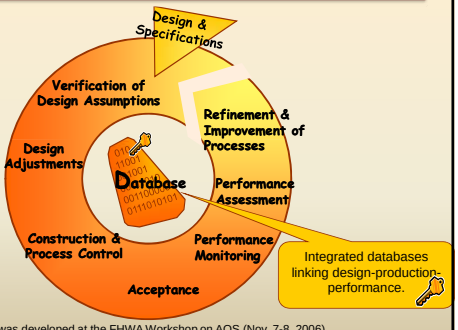
Advanced Quality Systems- Lifecycle Approach to Quality



•Basic Concept of AQSs was developed at the FHWA Workshop on AQS (Nov. 7-8, 2006)
•Original idea for this graphical rendition of AQSs was developed by Tom Harman, FHWA.

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Summary & Conclusions

- Both PRS and warranties are tools to achieve good quality and long-term performance
- PRS use models for predicting future performance:
  - Risk: pay adjustments depend on the accuracy of these models.
- Warranties use actual performance:
  - Risk: contractors have limited role in pavement type selection and design.

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Summary & Conclusions (cont.)

- AQSs are emerging as a framework for integrating and coordinating pavement processes and data
- AQSs aim at improving pavement performance throughout its lifecycle (close the loop).
- The core element of AQSs is integrated database.
- As AQSs mature, long-term performance specifications may become more appealing to agencies and contractors.

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Thank you for your attention!

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