

# **Kansas Department of Transportation**

**QC/QA for PCCP**

**TTCC/NCC Meeting**

**Indianapolis, IN**

**April 26 to April 28, 2011**

# Thoroughly Inspect PCCP





# Approved Quality Control Plan

- **2 Weeks before Paving**
  - **Quality Systems Manual**
  - **Corrective Actions**
  - **Equipment Calibration Records**
  - **Non-Conforming Materials**
  - **Concrete Mix Information**
  - **Chain of Command**



# Certified Inspectors

- Aggregate Field
- Profilograph
- ACI Concrete Field
- ACI Concrete Strength
- Nuclear Meters





# Laboratory Equipment

**AASHTO Accredited Lab**

**or**

**Annual Inspection**

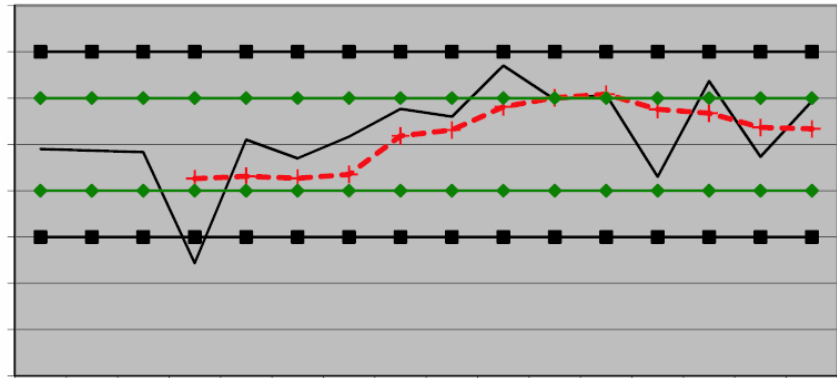
**by AAP Lab**



# Quality Control Charts (non-pay items)

## Individual Tests and 4 Point Moving Average

- Percent Air
- Slump
- Unit Weight
- Density
- Aggregate Gradations



# Incentive - Disincentive

**Pavement Smoothness (Non-QC/QA)**

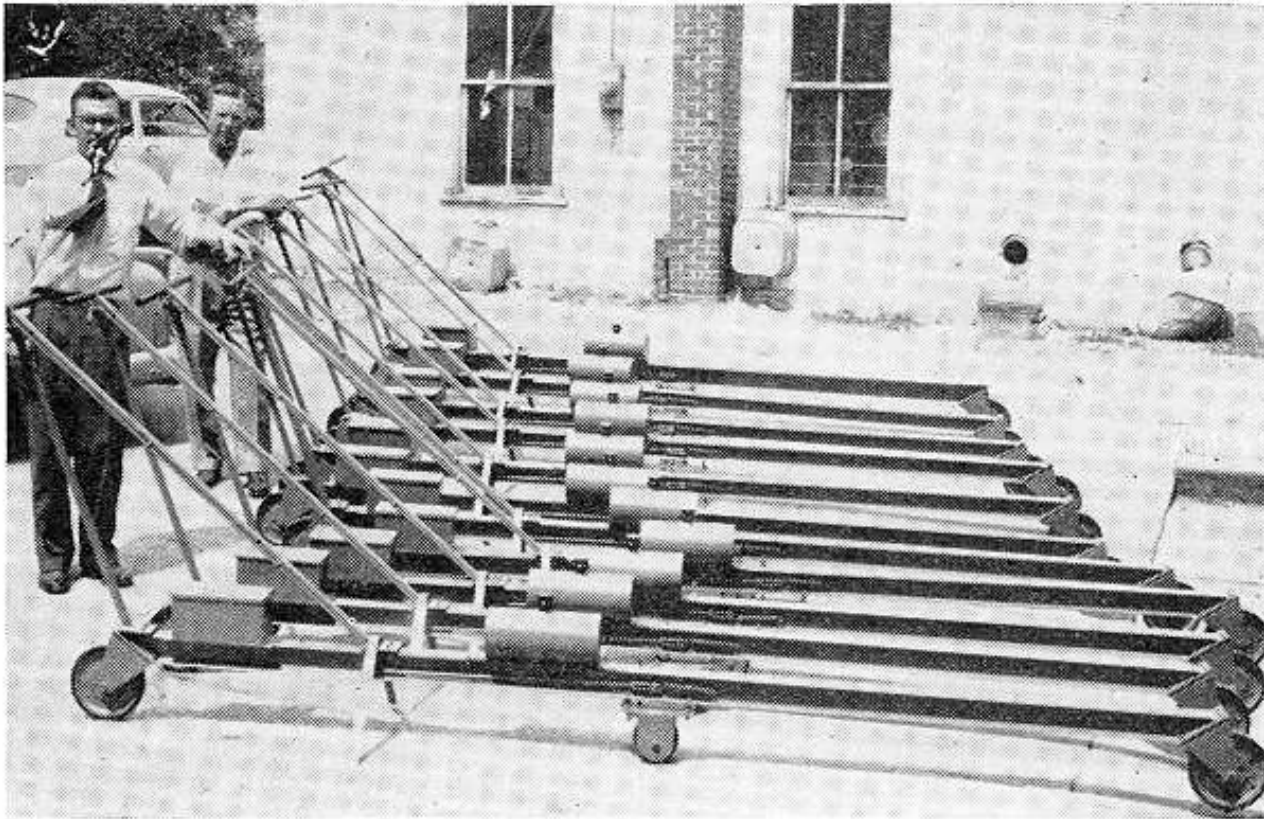
**Thickness (QC/QA)**

**Strength (QC/QA)**

**Gradation (QC/QA) – upon request**



# Over 20 Years Bonus Pay for Smoothness (Non-QC/QA)



# Contractors Data

## Zero Blanking Band

**TABLE 503-2: PCCP SMOOTHNESS PRICE ADJUSTMENT**

Average Profile Index Inch per mile per 0.1 mile section (Greater than 45 mph)	Average Profile Index Inch per mile per 0.1 mile section (45 mph or less & ramps)	Contract Price Adjustment Per 0.1 mile section per lane
6.0 or less		+ \$2000.00
6.0 to 10.0	15.0 or less	+ \$1670.00
10.1 to 15.0		+ \$1250.00
	15.1 to 25.0	+ \$830.00
15.1 to 18.0		+ \$620.00
18.1 to 30.0	25.1 to 45.0	0.00
30.1 to 40.0	45.1 to 65.0	0.00*
40.1 or more	65.1 or more	- \$1250.00*

\*Correct to 25.0 inch/mile (45.0 inch/mile for 45 mph or less & ramps)

# Make All Smoothness Corrections Before Coring for Thickness





# QC – QA PCCP

## Pay Factors for Thickness and Compressive Strength



# QC 3 to 5 Sublots per Lot

<b>TABLE 501-1: PCCP SUBLOT BREAKDOWN</b>	
<b>Daily Production Rate in square yards</b>	<b>Number of Sublots</b>
500 – 2000	3
2001 - 4000	4
4001 or more	5

# KDOT Test One Core per Lot

Obtain Core @ 21 days  
Test Core @ 28 days



# Measure Thickness



**Maximum Pay = Design Thickness + 1"**  
**(If we give them an inch, they'll take a mile)**



# Compressive Strength Cure and Test According to T-24



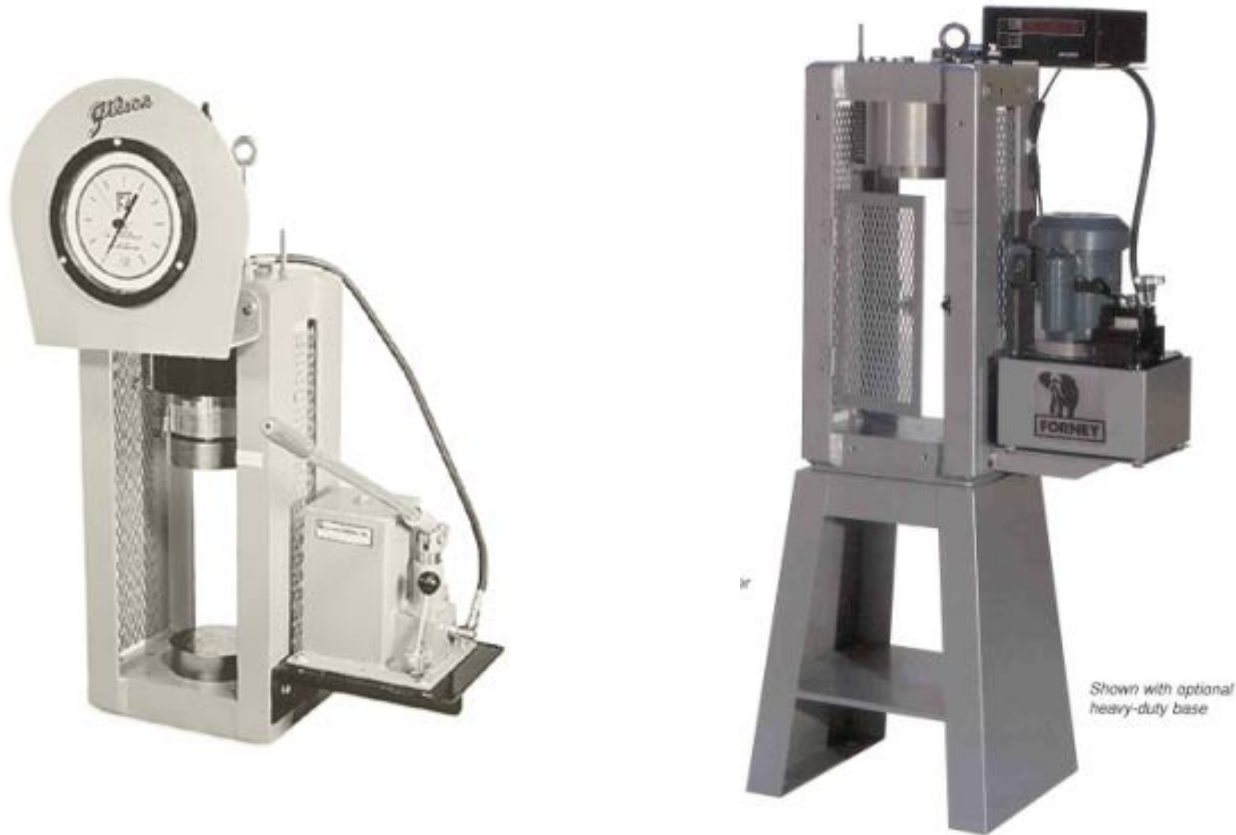
# Minimum Prep to Square Ends (Test entire length of core) (correct for L/D)



# Sulfur Capping Will Be Required On All Pavement Cores



# QA Cores Tested on Different Machine than the QC Cores



# Statistical Comparisons

- **F-test**

- Ho Variances are equal
- Ha Variances not equal

- **T-test**

- Ho Means are equal
- Ha Means not equal

SS2007 Section 501									
Lots:		Project #	K 7892-01	Name of QC Tester		Junior Samples			
Dates:	5/16/08	Contract #	509111888	Certification # of QC Tester			BR-549		
Compressive Strength Comparison									
Lot	Date	Corrected Contractor Compressive Strength (MPa)	Corrected KDOT Compressive Strength (MPa)	Number of Contractor Tests	Number of KDOT Tests	T Test	T(crit)	Are Means The Same?	Use Contractor Test Results?
1A1	5/16/2008	48.82	42.89						Yes
1A2									
1B1									
1B2									
1C1									
1C2									
1D1									
1D2									
1E1									
1E2									
2A1	5/17/2008	38.20	38.58	5	1			Pass	Yes
2A2									
2B1									
2B2									
2C1									
2C2									
2D1									
2D2									
2E1									
2E2									
3A1	7/22/2008	41.58	31.40	4	1				Yes
3A2									
3B1									
3B2									
3C1									
3C2									
3D1									
3D2									
3E1									
3E2									
4A1	7/23/2008	43.90	37.97	13	3	1.13	2.98	Pass	Yes
4A2									
4B1									
4B2									
4C1									

# Rejectable Quality Levels (Remove and Replace)

**Strength = 2900 PSI**



**Thickness = Design – 1"**



# Pay Factors are Based on Percent Within Limits (PWL)

To determine PWL Calculate the Quality Index

$$Q = \frac{(\bar{x} - LSL)}{S}$$

**Lower Spec Limit Strength = 3900**

**LSL Thickness = Design – 0.2”**



# Possibilities

Core 1	4200
Core 2	4900
Core 3	4800
Core 4	4150
Core 5	4100
Average	4430
Std Dev	386.65
LSL	3900
Q =	1.37

$$Q = \frac{(\bar{x} - LSL)}{s}$$

**Table 2 for Estimation of Lot Percent Within Limits  
Variability Unknown Procedure  
Standard Deviation Method**

Quality Index Q <sub>U</sub> or Q <sub>L</sub>	Percent Within Limits for Selected Sample Sizes												
	<u>N=3</u>	<u>N=4</u>	<u>N=5</u>	<u>N=6</u>	<u>N=7</u>	<u>N=8</u>	<u>N=9</u>	<u>N=10</u>	<u>N=15</u>	<u>N=20</u>	<u>N=30</u>	<u>N=50</u>	<u>N=100</u>
1.36	100.00	95.33	<u>93.21</u>	92.58	92.27	92.09	91.96	91.88	91.65	91.56	91.47	91.40	91.35
1.37	100.00	95.67	<u>93.44</u>	92.78	92.46	92.27	92.14	92.05	91.82	91.72	91.63	91.56	91.51
1.38	100.00	96.00	93.67	92.98	92.65	92.45	92.32	92.23	91.99	91.88	91.79	91.72	91.67
1.39	100.00	96.33	93.90	93.18	92.83	92.63	92.49	92.40	92.15	92.04	91.95	91.88	91.82
1.40	100.00	96.67	94.12	93.37	93.02	92.81	92.67	92.56	92.31	92.20	92.10	92.03	91.98
1.41	100.00	97.00	94.34	93.57	93.20	92.98	92.83	92.73	92.47	92.36	92.26	92.18	92.13
1.42	100.00	97.33	94.56	93.76	93.38	93.15	93.00	92.90	92.63	92.51	92.41	92.33	92.27
1.43	100.00	97.67	94.77	93.95	93.55	93.32	93.17	93.06	92.78	92.66	92.56	92.48	92.42

**PWL Tables developed by Corp of Engineers**

# Possibilities

<b>Core 1</b>	<b>4200</b>
<b>Core 2</b>	<b>4900</b>
<b>Core 3</b>	<b>4800</b>
<b>Core 4</b>	<b>4150</b>
<b>Core 5</b>	<b>4100</b>
<b>Average</b>	<b>4430</b>
<b>Std Dev</b>	<b>386.65</b>
<b>Q =</b>	<b>1.37</b>

$$Q = \frac{(\bar{x} - LSL)}{s}$$

Quality Index	Perce		
	<u>N=3</u>	<u>N=4</u>	<u>N=5</u>
1.36	100.00	95.33	93.21
1.37	100.00	95.67	93.44

**PWL = 93.44**

# Pay Factor for Thickness and Strength

$$P = \left( \frac{(PWL_T + PWL_S) * 0.60}{200} \right) - 0.54$$

**Maximum Bonus = 6% @ 100 PWL**

**No Bonus, No Deduct at 90 PWL**

**If mean < LSL, PWL=50, 24% Deduct**

$$Q = \frac{(\bar{x} - LSL)}{s}$$

***If it ain't broke,  
don't fix it!***

***If it ain't broke,  
you ain't tryin'.***



**Special Provision**  
**Contractors Option**

**Eliminate BONUS pay for Strength**  
**(Retain Penalty for Insufficient Strength)**

**Add Pay Factors for Gradation**

**Retain Pay Factors for Thickness**



***This may be our best idea  
yet, or, it may be too close  
to call.***



**TABLE 1102-7: GRADING REQUIREMENTS FOR MIXED AGGREGATES FOR CONCRETE**

Type	Usage	Percent Retained - Square Mesh Sieves									
		1"	¾"	½"	⅜"	No. 4	No. 8	No.16	No. 30	No. 50	No. 100
MA-3	Optimized for PCCP concrete	0	0-12 <sup>2</sup>	Note <sup>3,4</sup>	Note <sup>3,4</sup>	Note <sup>3,4</sup>	Note <sup>3,4</sup>	Note <sup>5</sup>	Note <sup>5</sup>	Note <sup>5</sup>	95-100

<sup>2</sup>If aggregate qualities fail to comply with Class 2 aggregate requirements, **subsection 1102.2a.**, the maximum retained gradation is restricted to 3%.

<sup>3</sup>Retain a maximum of 24% and a minimum of 6% of the material on each individual sieve.

<sup>4</sup>When Class 2 aggregate is used, retain a maximum of 20% on each individual sieve.

<sup>5</sup>Retain a maximum of 15% and a minimum of 6% of the material on each individual sieve.

**If the grading does not comply with the MA-3 grading requirements, then the subplot  $PWLg = 73.33$  or 95% Pay Factor.**

# Additional Requirements for MA-3

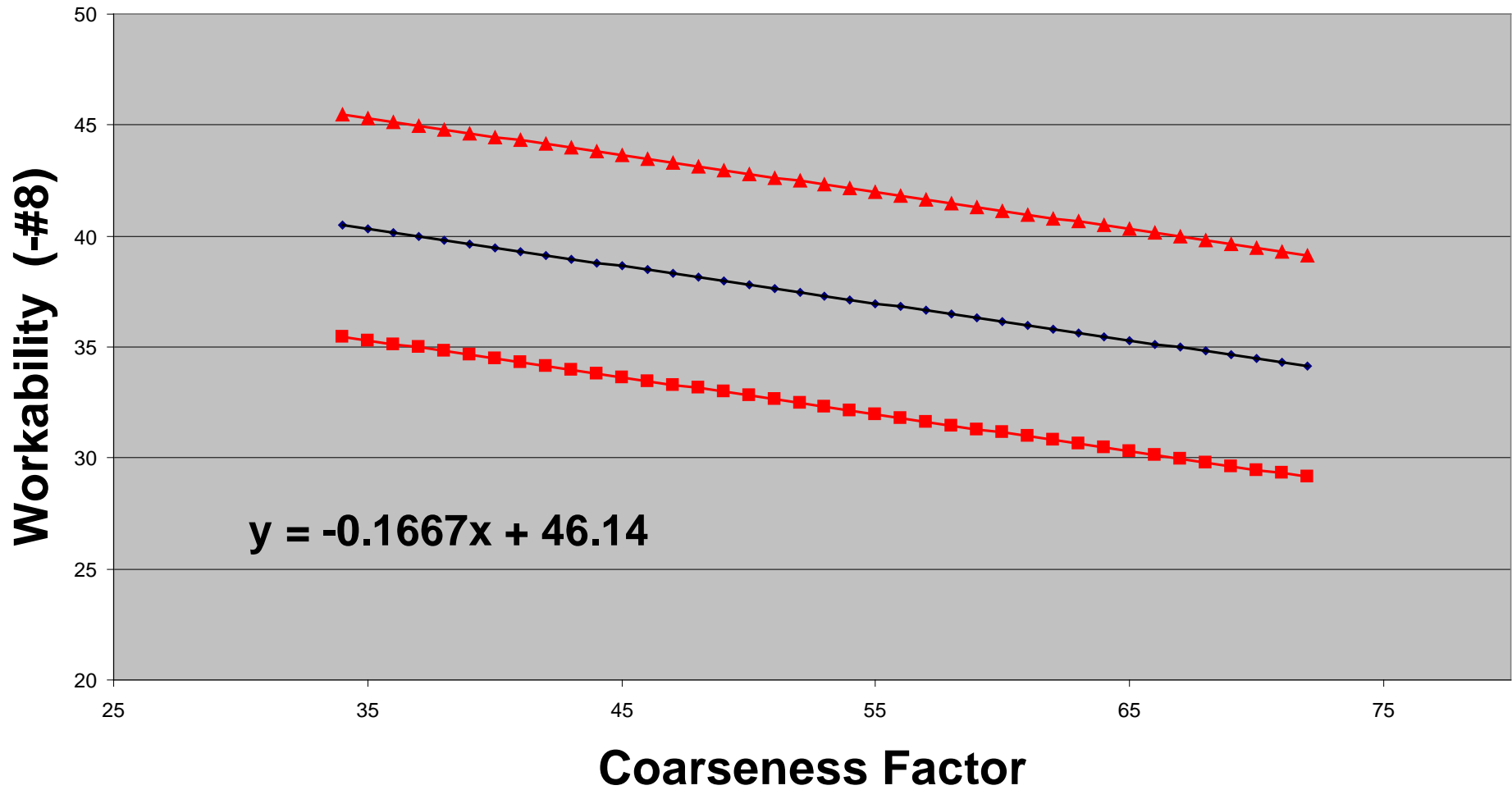
- **Actual Workability must be within  $\pm 5$  of Target Workability.**

$$\text{CF} = \frac{\text{+3/8'' (9.5 mm) Material \% Retained}}{\text{+ \# 8 (2.36 mm) Material \% Retained}} \times 100$$

$$\text{WA} = 100 - \% \text{retained on \#8 (2.36 mm) sieve}$$

$$\text{WT} = 46.14 - (\text{CF}/6)$$

# Coarseness Factor vs Workability



$$\text{CF} = \frac{\text{+3/8'' (9.5 mm) Material \% Retained}}{\text{+ \# 8 (2.36 mm) Material \% Retained}} \times 100$$

**Calculate the Coarseness Factor (CF)  
to the nearest whole number.**

**Calculate the Actual Workability (WA) to the nearest whole number as the percent material passing the #8 sieve.**

$$\text{WA} = 100 - (\% \text{retained on \#8 (2.36 mm) sieve})$$

**Calculate the Target Workability (WT)  
to the nearest whole number**

$$WT = 46.14 - (CF/6)$$

**For 521 lbs cement per cubic yard of concrete**



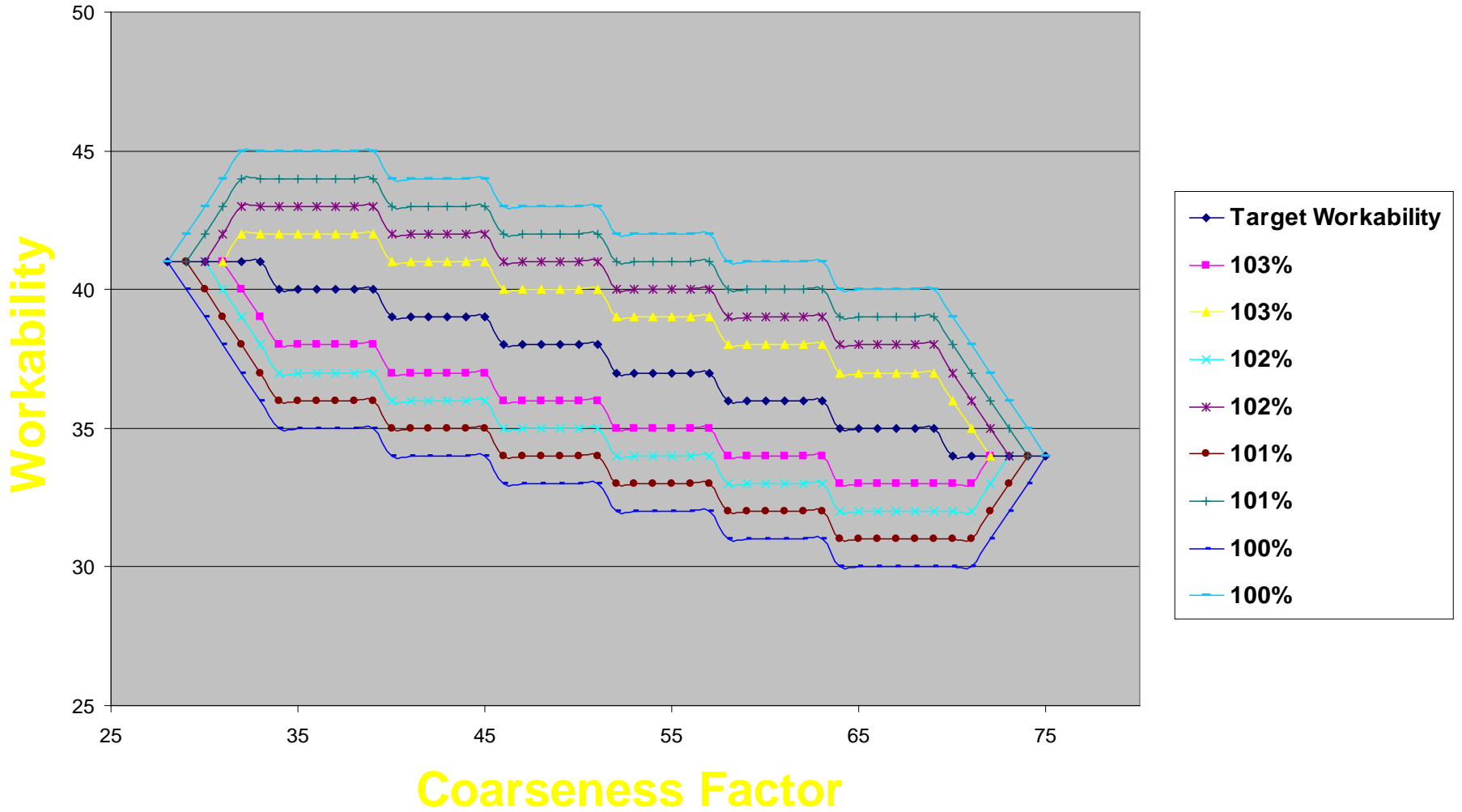


**For each additional 1 lb of cement  
per cubic yard, subtract  $(2.5/94)$   
from the  
Target Workability.**

**If the Actual Workability is less than 45, but more than 5 points above the target workability then the subplot *PWLG* = 80 or 97% Pay Factor.**

**If the Coarseness Factor is less than 25 or greater than 80 the pavement will be removed or left in place at no pay.**

# PCCP Bonus at 521 lbs Cement #2



**Gradation Lot is an Estimated  
Days Production**

**Maximum surface area per subplot is  
2000 sq yards – converted to tons.  
(Real Time)**

# Gradation Lots

**Sublot size can vary due to changes to plant settings that day.**



**Instead of this equation**

$$P = \left( \frac{(PWL_T + PWL_S) * 0.60}{200} \right) - 0.54$$

**We use this equation**

$$P = \left( \frac{(PWL_T + PWL_G) * 0.60}{200} \right) - 0.54$$

# Adjustments for Accelerated Schedule

- The basis of acceptance of most Accelerated Schedule Projects (weekend open to traffic) is flexural strength.
- If there are not 28 days to conduct compressive strength tests, then there is no QC/QA.
- We could maybe still conduct Thickness and Gradation on Accelerated Pavements.

**Any Questions?**