

Integration of Automated Distress Into PMS



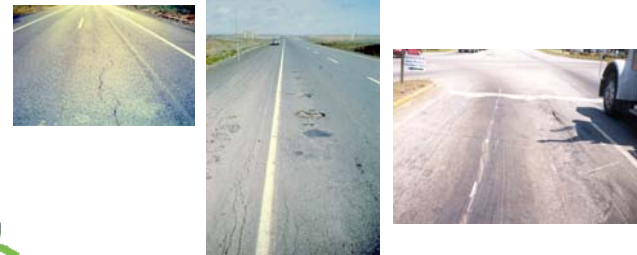
Katie Zimmerman, P.E.



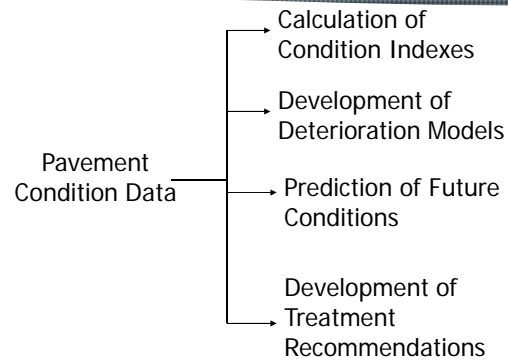
providing engineering solutions to improve pavement performance

Setting the Stage

- Role of pavement condition information in pavement management



Importance of Quality Data



Setting the Stage - Automated Collection

	Cracking	IRI	Rutting	Joint Faulting
Agency	10	31	30	21
Contract	20	23	21	12

NCHRP Synthesis 334 (McGhee 2004)

Setting the Stage - Automated Processing

	Cracking	IRI	Rutting	Joint Faulting
Agency	7	0	0	0
Contract	7	0	0	0



NCHRP Synthesis 334 (McGhee 2004)

Setting the Stage - Distress

	Manual	Photo	Video	Digital
State	17	0	13	15
Provincial	6	0	2	1
Federal	1	1	0	1
Total	24	1	15	17



NCHRP Synthesis 334 (McGhee 2004)

Setting the Stage

- Changes impacting pavement data collection



Setting the Stage

- Current pavement management data needs



Topic Areas

- Data quality using automated procedures
- Impacts of evolving technology on pavement management
- Sustaining the reliability of pavement management recommendations over time



Topic 1: Data Quality Using Automated Procedures

- What level of accuracy is reasonable and/or achievable?
- Are we collecting the right information?
- How do we ensure data quality?

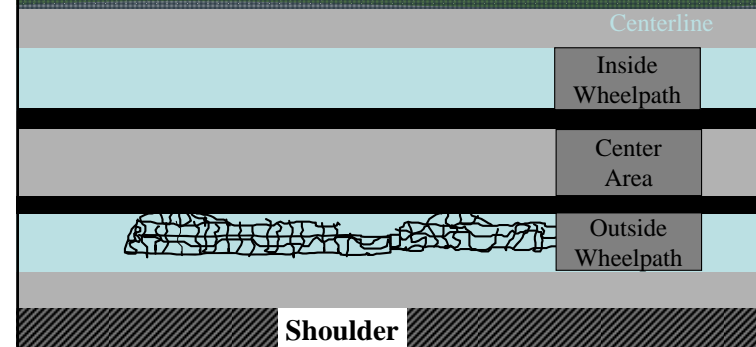


Factors Influencing Data Quality Using Automated Equipment

- Data collection conditions (lighting, sun angles, shadows)
- Data processing accuracy
- Speed of data processing
- QC/QA procedures



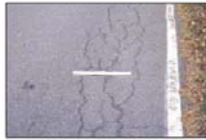
Distress ID By Location



Distress ID By Pattern



Low Severity



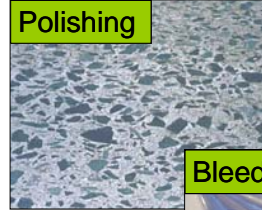
Moderate Severity



High Severity



Are We Collecting the Right Information?



Polishing



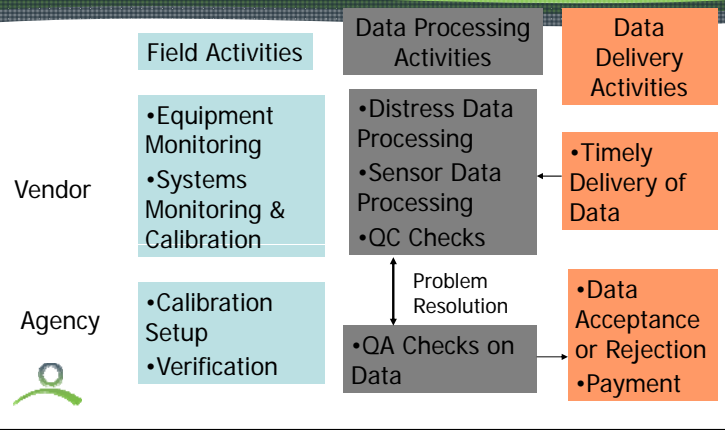
Friction



Bleeding/Flushing



Overview of QC/QA Activities



Sample Acceptability Requirements

DATA ELEMENT	REQUIRED MINIMUM ACCURACY	REQUIRED RESOLUTION (Measure to the Nearest)	REQUIRED MINIMUM REPEATABILITY
Rut Depth	+/- 0.08 inches compared to manual survey	0.01 inch	+/- 0.08 inches run to run for three repeat runs
International Roughness Index	+/- 5% compared to Rod & Level, Dipstick, or Class I profiler	1 in/mi	+/- 5% run to run for three repeat runs
Faulting	+/- 0.04 inches compared to manual survey	0.01 inch	+/- 0.04 inches run to run for three repeat runs

From Oklahoma DOT

Agency QA Checks

- Consistency
- Completeness
- Uniqueness of key fields
- Data reasonableness
- Acceptable data ranges
- Statistically representative of field conditions



Oklahoma DOT Pavement Data QA Tool



Sensor Data Range Checks

Variable	Value	Valid Range	Status	Ignore?
DATE	2/23/2003	3/1/2002 to 1/2/2005	Passed	<input type="checkbox"/>
SENSORS	21	31 to 31	Passed	<input type="checkbox"/>
IRI_RT		30 to 600	Blank	<input type="checkbox"/>
IRI_LT	600	30 to 600	Passed	<input type="checkbox"/>
IRI_AVG	120	30 to 600	Passed	<input type="checkbox"/>
FAULT_AVG	0	0 to 1	Passed	<input type="checkbox"/>
FAULT_MAX	0	0 to 1	Passed	<input type="checkbox"/>
FAULT_DEV	0	0 to 0.4	Passed	<input type="checkbox"/>
FAULT_CNT	0	0 to 31	Passed	<input type="checkbox"/>
RUT_AVG	0.21	0 to 1.25	Passed	<input type="checkbox"/>
RUT_MAX	0.28	0 to 2	Passed	<input type="checkbox"/>
RUT_1	100	0 to 100	Passed	<input type="checkbox"/>
RUT_2	0	0 to 100	Passed	<input type="checkbox"/>
TEXTURE	0.843	0 to 2	Passed	<input type="checkbox"/>

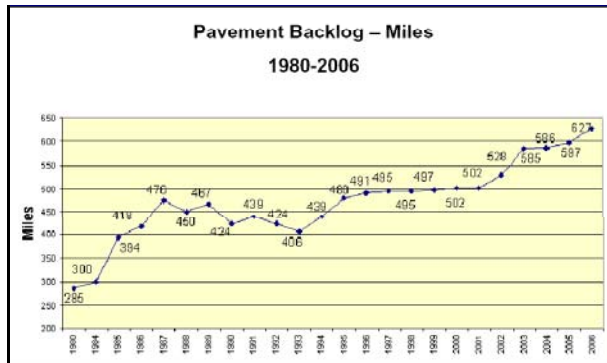


Automated Data Collection QC/QA Recommendations

- Provide data quality requirements in the RFP – make vendor responsible for quality of data
- Verify that the vendor is following its QC plan
- Get distress data in batches
- Require an early submittal of the data
- Check any data delivered by vendor
- Avoid second party relationships to vendor

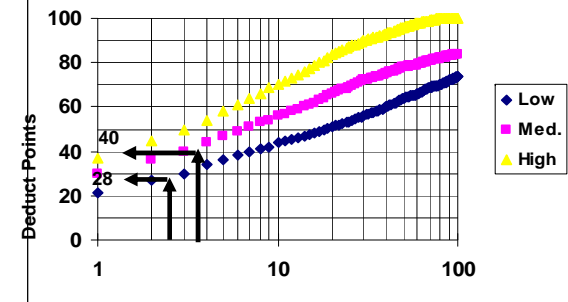


Topic 2: Impact of Equipment & Technology Changes on PMS



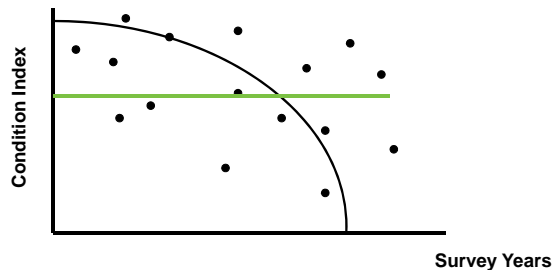
Consequence of Poor Data

Pavement Condition Index Deduct Curves (Corps of Engineers)



Quantity of Distress – Fatigue Cracking (% of area)

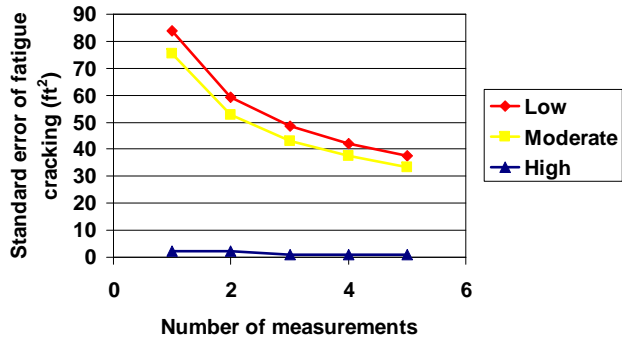
Consequence of Poor Data



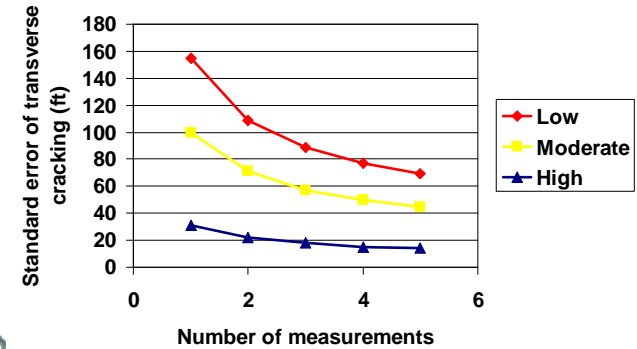
LTPP Data Analysis Support Contract – Task Order 0305

- Assess the variability of condition measurement information in pavement condition information
- Analyze impact of variability on pavement management system recommendations

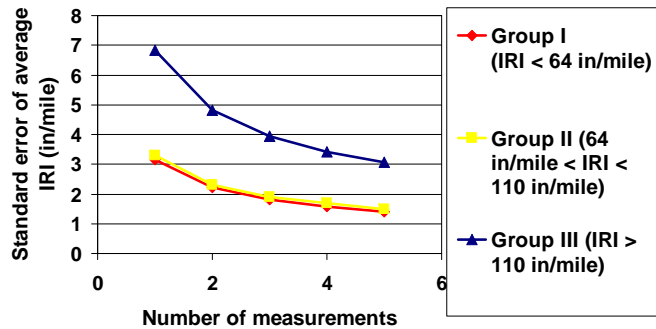
LTPP Data Analysis Study - Fatigue Cracking on AC



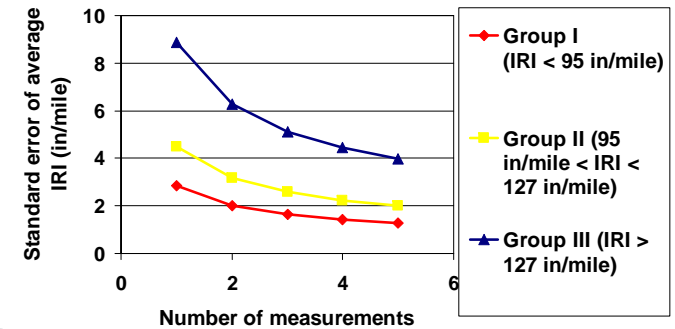
LTPP Data Analysis Study - Transverse Cracking on PCC



LTPP Data Analysis Study - AC IRI



LTPP Data Analysis Study - PCC IRI



Variability Example

- Rural AC pavement
- Distress present
 - 10% of wheel path with medium-severity fatigue cracking
 - Medium-severity transverse cracking spaced at 26-ft intervals
 - 10% of area with medium-severity block cracking



Standard Error of Average AC Distress Quantity

- Medium-severity fatigue cracking:
 - 75 ft²
- Medium-severity transverse cracking: 53 ft
- Medium-severity NWP longitudinal/block cracking: 38 ft



Distress Ratings

Distress Type	Extent			
	Low	Medium	High	Extreme
Fatigue cracking	1 to 9% of wheel path	10 to 24% of wheel path	25 to 49% of wheel path	> 49% of wheel patch
Transverse Cracking	> 50 ft spacing	25 - 50 ft spacing	< 25 ft spacing	
Block Cracking	1 to 9% of area	10 to 49% of area	> 50% of area	



Conversion of Distress Information

- Standard surveyed section
 - Length – 1,320 ft (Quarter mile)
 - Width – 12 ft
 - Area – 15,840 ft²
 - Wheel path area – 2,640 ft²
- Distress Present
 - Fatigue Cracking (10% of wheel path) – 264 ft²
 - Transverse Cracking (26 ft spacing) – 634 ft
 - NWP longitudinal/block cracking (10% of area) – 1584 ft² or 1584 ft (if assuming 1ft width)



Adjusted Distress Values Based on Standard Errors

Low Distress Values

Fatigue cracking:
264 - 75 = 189 ft²

Transverse cracking:
634 - 53 = 581 ft

NWP longitudinal/
block cracking:
1584 - 38 = 1546 ft

• High Distress Values

• Fatigue cracking:
• 264 + 75 = 339 ft²

• Transverse cracking:
• 634 + 53 = 687 ft

• NWP longitudinal/
block cracking:
• 1584 + 38 = 1622
ft



Adjusted Distress Values Based on Standard Errors

Low Distress Values

Fatigue cracking:
189 ft² = 7% of wheel
path

Transverse cracking:
581 ft = 27.5 ft
spacing

NWP longitudinal/
block cracking:
1546 ft² = 9.8% of
area

High Distress Values

Fatigue cracking:
339 ft² = 13% of wheel
path

Transverse cracking:
687 ft = 23 ft spacing

NWP longitudinal/
block cracking:
1622 ft² = 10.2% of
area



Distress Ratings

Distress Type	Extent			
	Low	Medium	High	Extreme
Fatigue cracking	1 to 9% of wheel path	10 to 24% of wheel path	25 to 49% of wheel path	> 49% of wheel patch
Transverse Cracking	> 50 ft spacing	25 - 50 ft spacing	< 25 ft spacing	
Block Cracking	1 to 9% of area	10 to 49% of area	> 50% of area	



Fatigue Cracking Index Deduct Values

SEVERITY	EXTENT			
	Low	Moderate	High	Extreme
Low	0.4	0.8	1.4	2.0
Medium	0.8	1.7	3.1	5.0
High	1.1	2.7	5.0	5.0

Low value

High value



Transverse Cracking Index Deduct Values

SEVERITY	EXTENT		
	Low	Moderate	High
Low	0.1	0.2	0.5
Medium	0.2	0.6	1.5
High	1.0	2.2	5.0

Low value

High value



Block Cracking Index Deduct Values

SEVERITY	EXTENT		
	Low	Moderate	High
Low	0.7	1.2	2.0
Medium	0.8	1.6	3.0
High	0.9	2.2	5.0

Low value

High value



Summary of Deduct Values and Resulting Index

Distress Type	Low Value		High Value	
	Deduct	Index	Deduct	Index
Fatigue cracking	0.8	4.2	1.7	3.3
Transverse cracking	0.6	4.4	1.5	3.5
NWP longitudinal/block cracking	0.8	4.2	1.6	3.4



Treatment Rule for AC Overlay and Selected Treatment

$$2.0 \leq FTCR \leq 3.5$$

$$TRCR \leq 4.0$$

$$2.0 \leq BLCR \leq 3.4$$

Distress Type	Low Value Index	High Value Index
Fatigue cracking (FTCR)	4.2	3.3
Transverse cracking (TRCR)	4.4	3.5
NWP/block cracking (BLCR)	4.2	3.4
Selected Treatment	None	AC Overlay



Impact of Data Variability on Treatment Selection

- Influenced by:
 - Survey type
 - Deduct values
 - Treatment rules



Mn/DOT Impact of Variability Analysis Setup

- Used LTPP condition data with Mn/DOT decision trees
- Applied standard deviations and COV from LTPP data analysis



Mn/DOT Impact of Variability Analysis Results

- The better the condition of the pavement the more consistent the chosen treatment
- The variability of PCC condition data had more impact on selected treatments compared to AC
- Changes in IRI had little effect on chosen treatments



Things To Remember

- LTPP data variability may be less than data variable in some network-level condition surveys used by state agencies
- Some methods of data collection may have greater precision but are less accurate



Guidelines for Minimizing the Impact of Variability

- Data collection procedures
 - Know the variability of existing procedures
 - Increase survey procedure training and documentation
 - Sample the same location from year to year



Guidelines for Minimizing the Impact of Variability

- QC/QA procedures
 - Increase verification methods
 - Utilize QC early in the data collection process
 - Conduct multiple QA checks at the same location for better statistical comparison



Guidelines for Minimizing the Impact of Variability

- Index calculation
 - Determine contribution of distress types and severities
 - Reduce weight of highly variable distress types
 - Assess the magnitude of deducts used
- Treatment rules
 - Determine contribution of distress types and severities
 - Evaluate if the range of condition indexes used in the treatment rule covers the variability of the index



Topic 3: Sustaining the Reliability of PMS Over Time

- Consistency
- Calibration
- Compatibility
- Communication





Thank you!

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