

Pavement Condition Forecasting System (PCFS)

A Network Level Funding & Strategy Analysis Tool

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What is the PCFS?

- Network/probabilistic spreadsheet-based for forecasting system condition
- PCFS started out as BridgeCFS
 - Developed initially for MDOT's bridge strategy in mid-1990s
 - Successfully used and improved since

Why Did We Develop This?

- Michigan Transportation Asset Management Council
TAMC established 2002.
 - Charged to report pavement condition and an asset management strategy to legislature and Transportation Commission
 - Started PASER data collection (rating system)
 - Selected RoadSoft as the strategic Pavement Management System

From Bridges to Pavements

- RoadSoft is a pavement management tool:
 - Requires several years of high quality data for:
 - Pavement conditions
 - Project executions, and cost
 - Pretty strict definitions of project types
 - Good quality “Born On” years, and pavement types
 - We didn’t have the data to execute statewide
 - What might exist in “good enough” form for one agency cannot be said across 617+ agencies
- Put Pavement data into the BCFS, and then we had a pavement tool.

Deterministic Models

- Forecast future condition of *pavements*
 - (*pavement chunks/segments*)
- Advantages
 - Regression based (reasonably simple)
 - Can develop a multitude of deterioration shapes
 - Can determine accuracy w/r/t actual data
 - Can be updated with results of future analysis/data

Deterministic Models

- Disadvantages
 - Require lots of high quality/accurate data
 - Need to include relevant variables that affect pavement deterioration
 - Hard to quantify factors these
 - Cannot address pavement behavior under different traffic/environmental conditions
 - Accuracy influenced by rehabilitation and maintenance activities
 - Not strictly accurate to apply statistical methods to pavement condition categories
 - Measurement error from subjective evaluation

Markov (Probabilistic) Models

Advantages

- Forecast future condition of *networks – groups of roads*
- Relatively simple implementation and use
 - Based on transitions of pavements from one condition state, to another, over time ---Transition Probability Matrix
 - Models how pavements actually perform, as a network
- Leverages high level data that already exists
- Uses those variables policy makers can control – budget, strategy, goals
 - Can identify future actions by varying policy variables
- Policy Variables:
 - Budget levels and allocation to improvement types
 - Determination of pavement strategies

Markov (Probabilistic) Models

(disadvantages)

- Challenges
 - Developing transition matrices
 - A Transition Matrix describes how pavements move from one condition to another, over time
 - Traditionally developing matrices has been done using expert opinion. The Transportation Asset Management Council had several years of data that could be used

Communication Advantages

- Can explain the model to policy-makers/decision makers without making them deal with the details of a deterministic system
 - Showing and explaining the model increases confidence in results
 - Improves institutional credibility – not a black box
- Staff is currently working with legislators on proposals based on the model results
- Underlying system condition data is not in question, and has been adopted across transportation agencies,
- System condition data also shows up as backdrops to the Governor's Infrastructure presentations

Pavement Condition Forecast System: Trunkline

Paved Fed-Aid Trunkline Only (Fwy & NonFwy); RQFS & Act 51 Budget, PASER
2009/10 to 2011 change matrix; no new revenue

Project Costs per Lane Mile (weighted average)	
Capital Preventive Maintenance (CPM)	\$58,284
Rehabilitation	\$460,180
Reconstruct	\$1,320,040

First Year of Simulation	2013
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Year Discount Rate Begins	2015
Discount Rate (inflation)	5%

Year	Budget	Discounted Budget	% PM	% Rehab	% Repl	Total
2013	\$465,000,000	\$465,000,000	20%	50%	30%	100%
2014	\$465,000,000	\$465,000,000	20%	50%	30%	100%
2015	\$465,000,000	\$465,000,000	20%	50%	30%	100%
2016	\$465,000,000	\$442,857,143	20%	50%	30%	100%
2017	\$465,000,000	\$421,768,707	20%	50%	30%	100%
2018	\$465,000,000	\$401,684,483	20%	50%	30%	100%
2019	\$465,000,000	\$382,556,651	20%	50%	30%	100%
2020	\$465,000,000	\$364,339,667	20%	50%	30%	100%
2021	\$465,000,000	\$346,990,159	25%	40%	35%	100%
2022	\$465,000,000	\$330,466,819	25%	40%	35%	100%
2023	\$465,000,000	\$314,730,303	25%	40%	35%	100%
2024	\$465,000,000	\$299,743,146	25%	40%	35%	100%
2025	\$465,000,000	\$285,469,663	25%	40%	35%	100%
Total	\$6,045,000,000	\$4,985,606,742.07				
Annual AVG	\$465,000,000					

Pavement Condition Rating (PASER)(Extrapolated Lane Miles) Improvement Strategy

Capital Preventive Maintenance (CPM)											
Worked On	1	2	3	4	5	6	7	8	9	10	Check
	0.00%				33.33%	33.33%	33.34%				100.00%
Moved to	1	2	3	4	5	6	7	8	9	10	Check
	0.00%							100.00%	0.00%	0.00%	100.00%

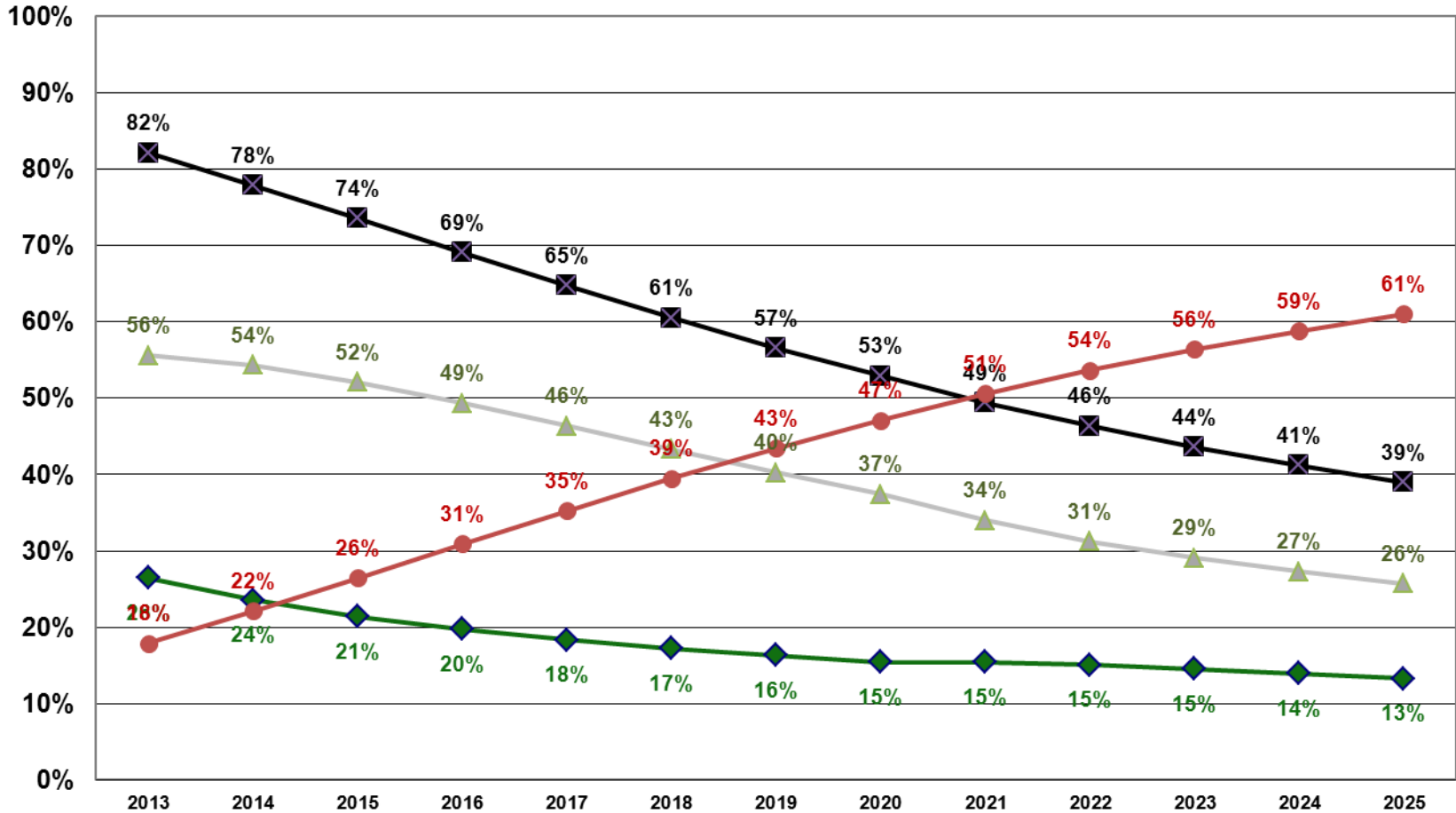
Rehabilitation											
Worked On	1	2	3	4	5	6	7	8	9	10	Check
	0.00%	0.00%	50.00%	50.00%							100.00%
Moved to	1	2	3	4	5	6	7	8	9	10	Check
	0.00%							0.00%	100.00%	0.00%	100.00%

Reconstruct											
Worked On	1	2	3	4	5	6	7	8	9	10	Check
	50.00%	50.00%									100.00%
Moved to	1	2	3	4	5	6	7	8	9	10	Check
	0.00%								0.00%	100.00%	100.00%

Forecast of Pavement Condition

Trunkline Paved Federal Aid

Good Fair Poor

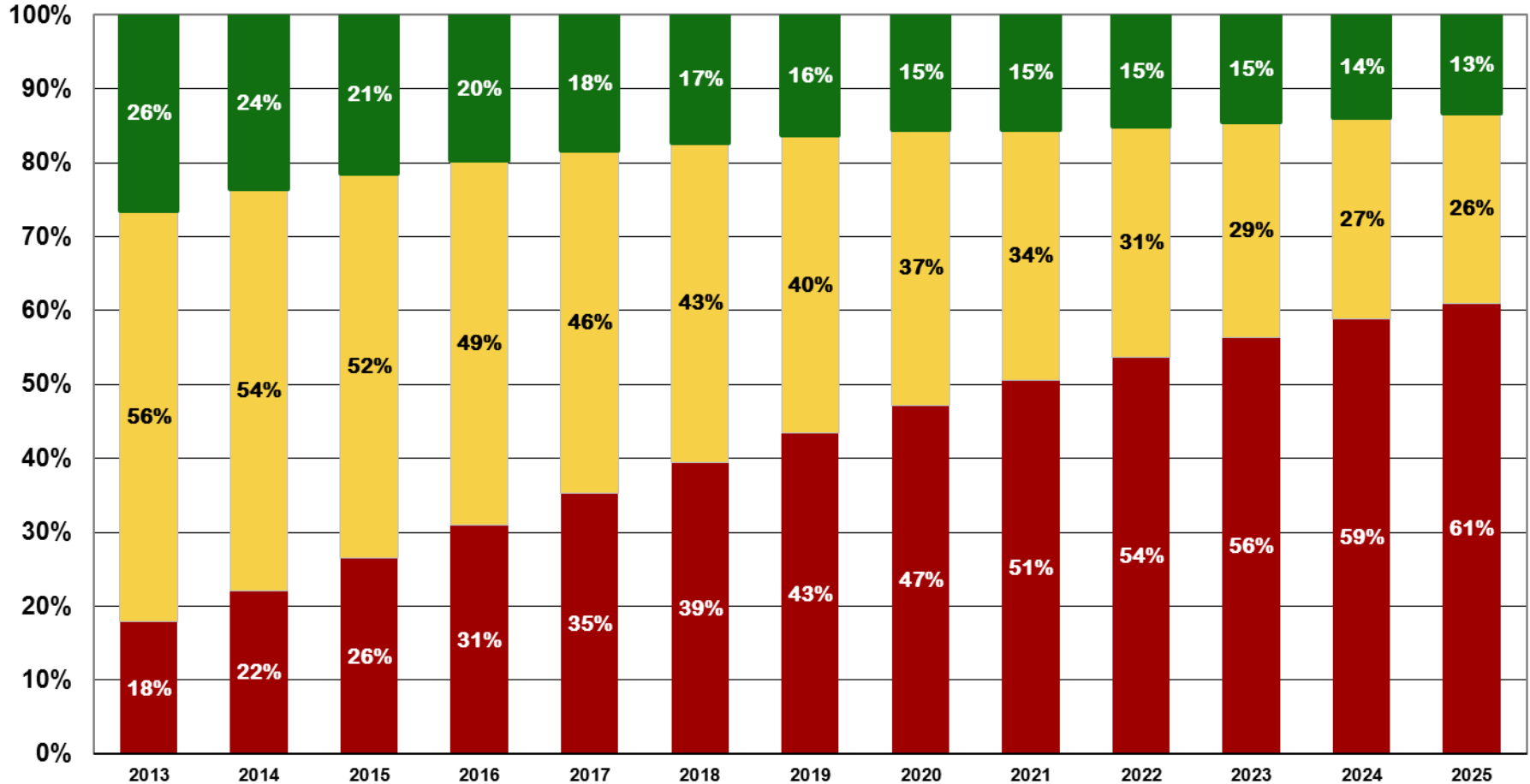


■ Percent Good & Fair ◆ Percent Good ▲ Percent Fair ● Percent Poor

Forecast of Pavement Condition

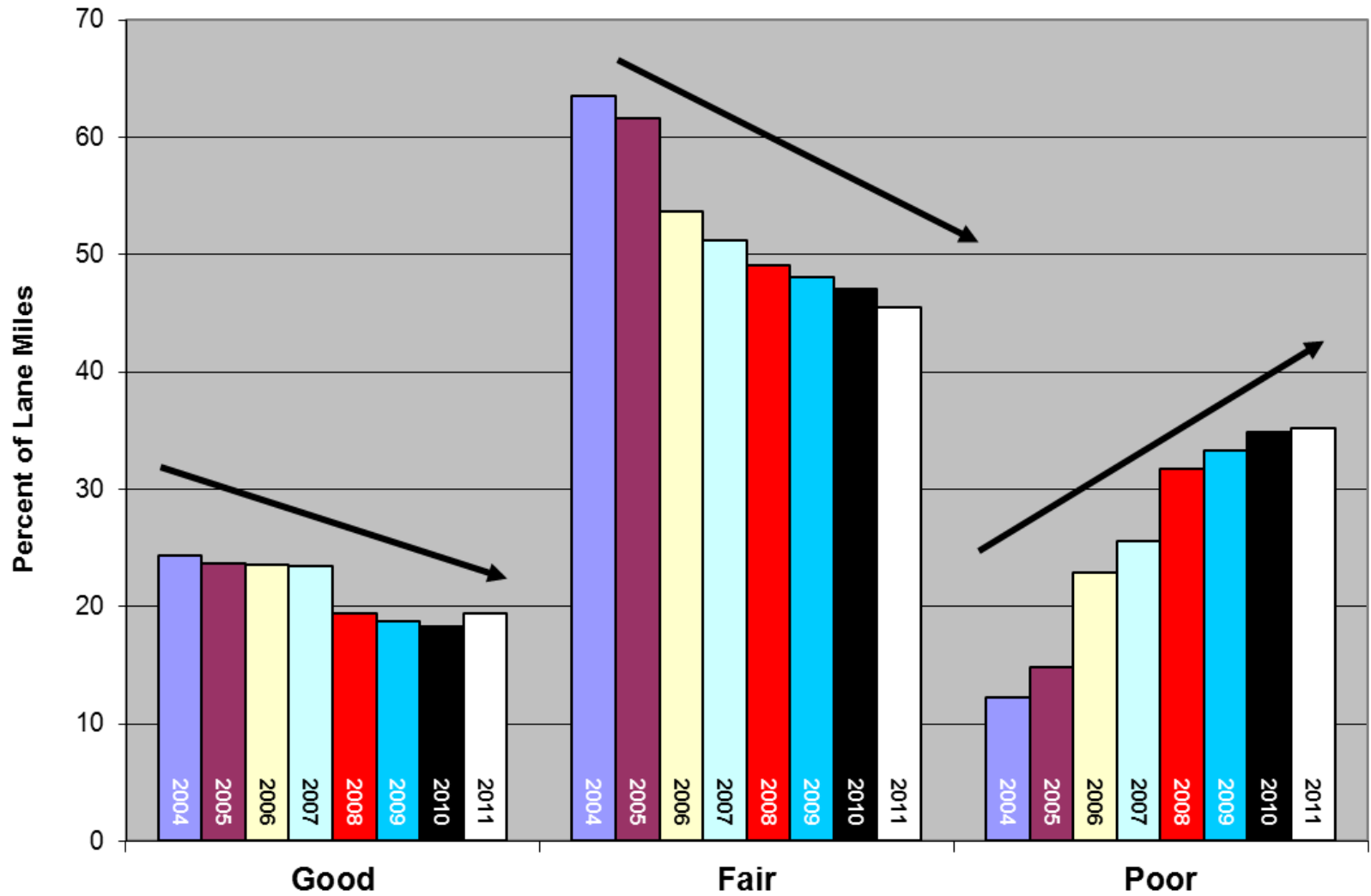
Trunkline Paved Federal Aid

Good Fair Poor



■ Percent Poor ■ Percent Fair ■ Percent Good

2004-2011 Pavement Condition of Federal Aid Eligible Roads



Expenditures & Work Performed

Trunkline Federal-Aid Roads											
Strategy					29,456	Total Lane Miles					
Year	Budget	%PM	% Rehab	% Recon.	Reconstruct Budget	Reconstruct Lane Miles	Rehab Budget	Rehab Lane Miles	PM Budget	PM Lane Miles	Total Lane Miles
2013	\$465,000,000	0.2	0.5	0.3	\$139,500,000	106	\$232,500,000	505	\$93,000,000	1,596	2,207
2014	\$465,000,000	0.2	0.5	0.3	\$139,500,000	106	\$232,500,000	505	\$93,000,000	1,596	2,207
2015	\$465,000,000	0.2	0.5	0.3	\$139,500,000	106	\$232,500,000	505	\$93,000,000	1,596	2,207
2016	\$442,857,143	0.2	0.5	0.3	\$132,857,143	101	\$221,428,571	481	\$88,571,429	1,520	2,102
2017	\$421,768,707	0.2	0.5	0.3	\$126,530,612	96	\$210,884,354	458	\$84,353,741	1,447	2,001
2018	\$401,684,483	0.2	0.5	0.3	\$120,505,345	91	\$200,842,242	436	\$80,336,897	1,378	1,905
2019	\$382,556,651	0.2	0.5	0.3	\$114,766,995	87	\$191,278,325	416	\$76,511,330	1,313	1,816
2020	\$364,339,667	0.2	0.5	0.3	\$109,301,900	83	\$182,169,834	396	\$72,867,933	1,250	1,729
2021	\$346,990,159	0.25	0.4	0.35	\$121,446,556	92	\$138,796,064	302	\$86,747,540	1,488	1,882
2022	\$330,466,819	0.25	0.4	0.35	\$115,663,386	88	\$132,186,727	287	\$82,616,705	1,417	1,792
2023	\$314,730,303	0.25	0.4	0.35	\$110,155,606	83	\$125,892,121	274	\$78,682,576	1,350	1,707
2024	\$299,743,146	0.25	0.4	0.35	\$104,910,101	79	\$119,897,258	261	\$74,935,787	1,286	1,626
2025	\$285,469,663	0.25	0.4	0.35	\$99,914,382	76	\$114,187,865	248	\$71,367,416	1,224	1,548
Total	\$4,985,606,742				\$1,574,552,027	1,194	\$2,335,063,362	5,074	\$1,075,991,353	18,461	24,729
			Cost Per Lane Mile				\$1,318,720		\$460,202		\$58,285
						Year	Reconstruct	Rehab		PM	Total
						2013	0.36%	1.71%		5.42%	7.49%
						2014	0.36%	1.71%		5.42%	7.49%
						2015	0.36%	1.71%		5.42%	7.49%
						2016	0.34%	1.63%		5.16%	7.14%
						2017	0.33%	1.55%		4.91%	6.79%
						2018	0.31%	1.48%		4.68%	6.47%
						2019	0.30%	1.41%		4.46%	6.17%
						2020	0.28%	1.34%		4.24%	5.87%
						2021	0.31%	1.03%		5.05%	6.39%
						2022	0.30%	0.97%		4.81%	6.08%
						2023	0.28%	0.93%		4.58%	5.80%
						2024	0.27%	0.89%		4.37%	5.52%
						2025	0.26%	0.84%		4.16%	5.26%
						Total	4.05%	17.23%		62.67%	83.95%
										Avg.	6.46%

Caveats

- Transition matrices need to be kept current
 - Changing mix of fixes will change deterioration
 - Large changes cause instability
- Be conscious of ability to execute strategies
 - Public can only tolerate X% of the roads being under construction at a time
 - Have to double check enthusiasm when working on alternatives

Proposed Pavement Performance Models for Local Government Agencies in Michigan

DeSilva, Fernando di Melo e, Van Dam, Thomas J., Bulleit,
William M., Ylitalo, Ross, "Proposed Pavement Performance
Models for Local Government Agencies in Michigan",
Transportation Research Record 1699, Washington, DC
2000, pp. 81-86.

Want the Spreadsheet?

- Please e-mail me at vibbertr@michigan.gov
 - We're putting together documentation to explain the model and its structure.