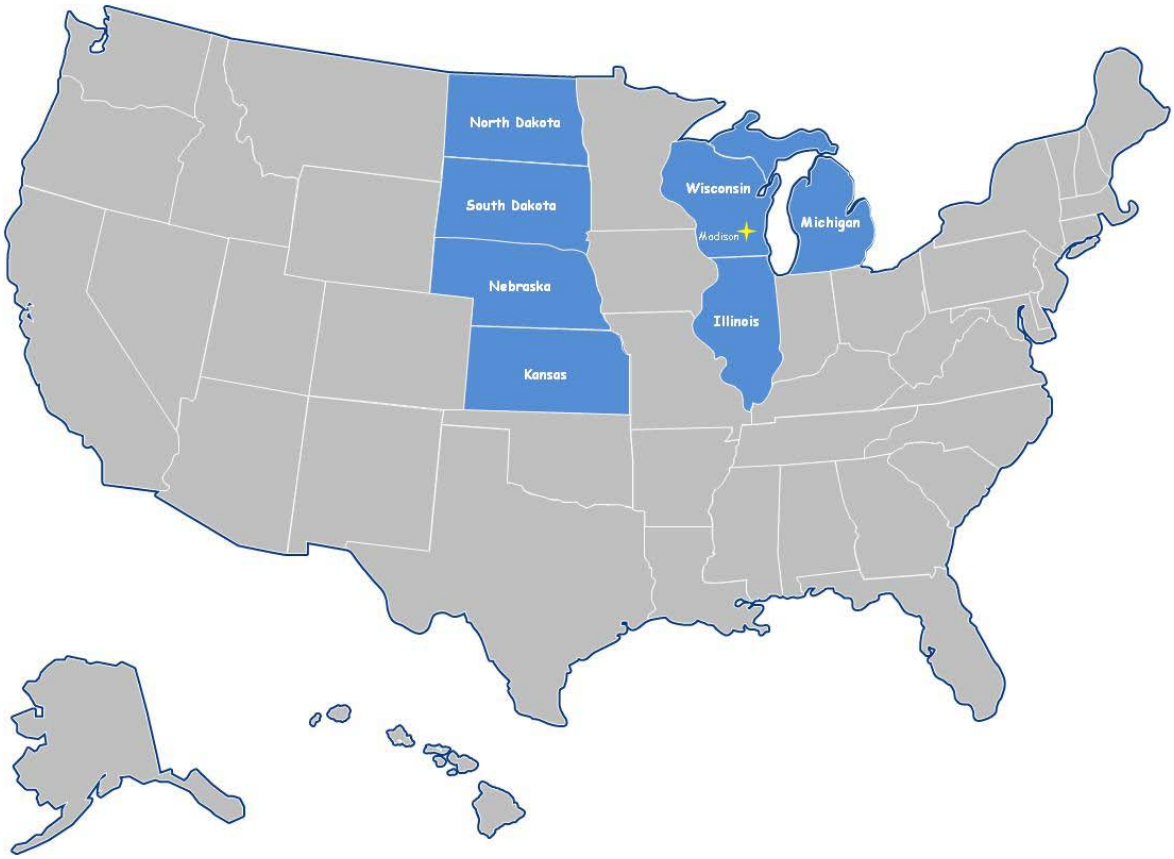
U.S. Department of Transportation
Federal Highway Administration

PEER EXCHANGE PROGRAM

Pavement Management Practices in State Highway Agencies: Madison, Wisconsin Peer Exchange Results



Final – January 5, 2011

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U.S. Department of Transportation
Federal Highway Administration

Pavement Management Practices in State Highway Agencies: Madison, Wisconsin Peer Exchange Results

Submitted to the Federal Highway Administration
US Department of Transportation

Prepared by MACTEC Engineering and Consulting, Inc.
12104 Indian Creek Court, Suite A
Beltsville, Maryland 20705

In association with

R. Gary Hicks, LLC
791 Hillgrove Court
Chico, CA 95926

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FOREWORD

The Federal Highway Administration Office of Asset Management has performed a series of Pavement Management Peer Exchange Workshops. The purpose of these workshops is to provide participating state agencies a forum to discuss issues of mutual interest in the field of pavement management and promote information exchange between participating agencies.

This document reports on the discussions held at the fourth such Peer Exchange held on August 24-25, 2010 in Madison, Wisconsin. The peer exchange had representatives from the following agencies:

- Illinois Department of Transportation (IDOT)
- Kansas Department of Transportation (KDOT)
- Michigan Department of Transportation (MDOT)
- Nebraska Department of Roads (NDOR)
- North Dakota Department of Transportation (NDDOT)
- South Dakota Department of Transportation (SDDOT)
- Wisconsin Department of Transportation (WISDOT)
- FHWA Division Offices
- FHWA Office of Asset Management

The report presents a summary of the states' practices in each of the following topics:

- Using pavement management data to support decision making
- Using pavement management data for short- and long-term planning
- Establishing links with pavement preservation and maintenance and operations
- Developing performance models and performance measures using pavement condition information
- Economics of pavement management - cost effectiveness and cost savings
- Communicating and marketing the importance of pavement management

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16. Abstract

This report summarizes the results of a 2-day Peer Exchange on Pavement Management held in Madison, Wisconsin on August 24-25, 2010. The participating states include the following: Illinois, Kansas, Michigan, Nebraska, North Dakota, South Dakota, and Wisconsin. Representatives from each of the DOTs and their FHWA Division counterpart attended the meeting. The report includes a summary of the states' practices and a discussion on each of the following topics:

- Using pavement management data to support decision making
- Using pavement management data for short-and long-term planning
- Establishing links with pavement preservation and maintenance and operations
- Developing performance models and performance measures using pavement condition information
- Economics of pavement management - cost effectiveness and cost savings
- Communicating and marketing the importance of pavement management

This report summarizes the discussions at the meeting.

17. Key Words	18. Distribution Statement
Pavement, pavement performance, pavement preservation, pavement rehabilitation, pavement maintenance, extended service life, pavement management, hot mix asphalt, portland cement concrete	No restrictions.

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Unclassified	Unclassified	32	

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SI* (MODERN METRIC) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
		AREA		
in^2	square inches	645.2	square millimeters	mm^2
ft^2	square feet	0.093	square meters	m^2
yd^2	square yard	0.836	square meters	m^2
ac	acres	0.405	hectares	ha
mi^2	square miles	2.59	square kilometers	km^2
		VOLUME		
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
		NOTE: volumes greater than 1000 L shall be shown in m^3		
		MASS		
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
		TEMPERATURE (exact degrees)		
°F	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	°C
		ILLUMINATION		
fc	foot-candles	10.76	lux	lx
fl	foot-Lamberts	3.426	$candela/m^2$	cd/m^2
		FORCE and PRESSURE or STRESS		
lbf	poundforce	4.45	newtons	N
lbf/in^2	poundforce per square inch	6.89	kilopascals	kPa

APPROXIMATE CONVERSIONS FROM SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
		LENGTH		
mm	millimeters	0.039	inches	in
m	meters	3.28	feet	ft
m	meters	1.09	yards	yd
km	kilometers	0.621	miles	mi
		AREA		
mm^2	square millimeters	0.0016	square inches	in^2
m^2	square meters	10.764	square feet	ft^2
m^2	square meters	1.195	square yards	yd^2
ha	hectares	2.47	acres	ac
km^2	square kilometers	0.386	square miles	mi^2
		VOLUME		
mL	milliliters	0.034	fluid ounces	fl oz
L	liters	0.264	gallons	gal
m^3	cubic meters	35.314	cubic feet	ft^3
m^3	cubic meters	1.307	cubic yards	yd^3
		MASS		
g	grams	0.035	ounces	oz
kg	kilograms	2.202	pounds	lb
Mg (or "t")	megagrams (or "metric ton")	1.103	short tons (2000 lb)	T
		TEMPERATURE (exact degrees)		
°C	Celsius	1.8C+32	Fahrenheit	°F
		ILLUMINATION		
lx	lux	0.0929	foot-candles	fc
cd/m^2	$candela/m^2$	0.2919	foot-Lamberts	fl
		FORCE and PRESSURE or STRESS		
N	newtons	0.225	poundforce	lbf
kPa	kilopascals	0.145	poundforce per square inch	lbf/in^2

*SI is the symbol for the International System of Units. Appropriate rounding should be made to comply with Section 4 of ASTM E380.
(Revised March 2003)

CHAPTER 1

Introduction

BACKGROUND

In its continuing efforts to provide research and technology transfer activities in support of improving pavement conditions nationwide, the Federal Highway Administration (FHWA) is sponsoring a series of Peer Exchange meetings. These meetings provide pavement management practitioners in state highway agencies (SHAs) throughout the United States with the opportunity to share pavement management practices and exchange ideas for using their tools to support agency decisions in the following areas:

- Data needs and quality
- Short- and long-term planning
- Treatment selection to improve pavement conditions
- Performance modeling and predicting future conditions

The Peer Exchange meetings also provide an opportunity for participants to share information about the cost of collecting and reporting pavement condition data and to identify national initiatives that could result in the development and deployment of innovative materials, processes, and technologies for the effective design, construction, rehabilitation, and maintenance of pavements. The Peer Exchange meetings focus on the use of pavement management tools to support agency decisions regarding the allocation and use of available funding to preserve the highway network.

The first Pavement Management Peer Exchange Meeting was held in February 2008. It included representatives from the New York and California Departments of Transportation and the FHWA. These individuals met with representatives from the Minnesota Department of Transportation in Maplewood, Minnesota on February 4-5, 2008 and then with representatives from the Utah Department of Transportation in Salt Lake City, Utah on February 7-8, 2008.

The second Pavement Management Peer Exchange Meeting was held in Nashville, Tennessee on September 23-24, 2009. Representatives from four SHAs and five FHWA Division offices participated in this meeting in addition to representatives from FHWA Headquarters and the Atlanta Resource Center.

The third Pavement Management Peer Exchange Meeting was held in Golden, Colorado on November 17-18, 2009. Six SHAs participated in the meeting along with representatives from FHWA Headquarters and Division offices. The meeting built on the framework introduced at the prior Pavement Management Peer Exchange Meetings.

This report documents the results of the fourth Pavement Management Peer Exchange held in Madison, Wisconsin on August 24-25, 2010. Seven SHAs and representatives from the FHWA Division office for each state were represented at the meeting. The format for the meeting was identical to that used for the meeting in Golden, Colorado.

At the writing of this report the previous Pavement Management Peer Exchange reports are in various stages of publication. When complete, they can be accessed through the FHWA website at:

http://www.fhwa.dot.gov/infrastructure/asstmgmt/index.cfm

PARTICIPATING AGENCIES

The participants in the Midwestern Peer Exchange included representatives from the following agencies:

- Illinois Department of Transportation (IDOT)
- Kansas Department of Transportation (KDOT)
- Michigan Department of Transportation (MDOT)
- Nebraska Department of Roads (NDOR)
- North Dakota Department of Transportation (NDDOT)
- South Dakota Department of Transportation (SDDOT)

- Wisconsin Department of Transportation (WISDOT)
- FHWA Division Offices in each state
- FHWA Office of Asset Management

Missouri DOT was invited but was unable to attend. The names of the participants in the Midwestern Peer Exchange are listed in Table 1-1.

Table 1-1. Participants in the Midwestern Peer Exchange Meeting

Agency	Participant Name
IDOT	Mr. Rob Robinson Ms. LaDonna Rowden
KDOT	Mr. Rick Miller Mr. Rick Kreider
MDOT	Mr. Craig Newell Ms. Selena Friend
NDOR	Mr. Dan Nichols
NDDOT	Ms. Jane Berger Ms. Stephanie Weigel
SDDOT	Mr. Blair Lunde Mr. Phil Clements
WISDOT	Mr. Joe Nestler Mr. Dave Fredrichs
FHWA Division Offices	IL-Brian Phiefer KS-Tom Deddens MI-Robert Conway NE-Frank Rich SD-Brett Hestdalen WI-Wesley Shemwell
FHWA Office of Asset Management	Mr. Stephan Gaj Ms. Nastaran Saadatmand Mr. Thomas Van

REPORT ORGANIZATION

The report includes the following chapters:

- Chapter 1: Introduction
- Chapter 2: Using pavement management data to support decision making
- Chapter 3: Using pavement management for short- and long-term planning
- Chapter 4: Establishing links with pavement preservation and maintenance operations
- Chapter 5: Developing performance models and performance measures using pavement condition information
- Chapter 6: The economics of pavement management: cost-effectiveness and cost savings
- Chapter 7: Communicating and marketing the importance of pavement management systems
- Chapter 8: Summary

Chapters 2 through 7 address the six topics discussed during the meeting. The first five topics were selected by FHWA. The sixth topic, communicating and marketing the importance of pavement management systems, was selected by the participants.

For chapters 2 through 7, the following topics were addressed for each issue:

- Topic Summary
- Current Practice Among Participating Agencies
- Issues Identified
- Needs to Enhance the Use of Pavement Management
- Highlighted Practices

An appendix providing background information about each of the participating SHAs is included in Appendix A.

CHAPTER 2

The Use of Pavement Management Data To Support Decision Making

TOPIC SUMMARY

The final measure of a successful pavement management system is the degree to which an agency's decisions are influenced by the output of the system. Pavement management systems are designed to assist agencies with planning and programming functions over the short - and long-term. As a result, most pavement management systems are designed to help in the following ways:

- Identify and prioritize maintenance and rehabilitation needs,
- Evaluate the cost effectiveness of various strategies, and
- Recommend projects and treatments under various budget scenarios.

In recent years, advancements in technology have allowed decision makers to extend pavement management's reach in other areas such as:

- Evaluation of pavement preservation needs,
- Determination of the cost effectiveness of preservation treatments, and
- Selection of optimal timing for preservation treatments.

This is leading to stronger and more effective pavement management systems in highway agencies.

During this session of the peer exchange, each agency had the opportunity to explain their current use of pavement management information to support agency decisions, the factors influencing the use of the pavement management output, and the future changes they hope to implement.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

After introducing the topic to the participating agencies, each agency was provided an opportunity to explain their current use of pavement management information to support the agency's decision making process.

Summary of Practice

A summary of data collection techniques, pavement management software, and the organizational location for the pavement management office for each of the agencies is summarized in Table 2-1. More detailed information about the practices being used in these areas is given in Appendix A. As shown in Table 2-1 and discussed in Appendix A, the participants use a variety of different approaches to data collection with some agencies contracting out the services and others collecting the pavement condition data in-house.

Pavement management software was either developed in-house (5 states) or provided by vendors (2 states). Four of the agencies locate pavement management in the planning section, two are located in the materials division, and one state's pavement management group is located in the construction and technology office. It is interesting to note that the pavement management activity within AASHTO is currently under the auspices of the materials group. Some of the agencies were not aware of this and they were encouraged to interact with the AASHTO materials group on issues dealing with pavement management through AASHTO.

Most agencies indicated that the success of their system is due to top management support and the strength of their central office pavement management activities.

The following sections summarize the current practices of each agency with respect to the use of pavement management data to support decision making. Following

Table 2-1. **Summary of practices in participating state highway agencies.**

State Highway Agency	Data Collection Approach and Vendor	Pavement Management Software Vendor	Organizational Location for Pavement Management
IDOT	Automated surveys are conducted under a contract with Pathways Services, Inc. (Pathways) since 2008.	In-house	Planning
KDOT	Automated surveys are conducted in-house using state-owned vehicles.	In-house (developed with Woodward-Clyde Consultants)	Materials
MDOT	Automated surveys have been conducted under a contract with Pathways since 1997.	In-house	Construction and Technology
NDOR	Automated surveys have been conducted in-house using a state-owned Pathways vehicle.	In-house	Materials and Research
NDDOT	Automated surveys are being conducted with a state-owned Pathways vehicle	Deighton	Planning
SDDOT	Automated surveys are conducted with a Pathways vehicle. Pavement distress collected manually.	Deighton	Planning, Project Development Office
WISDOT	Automated surveys used to collect roughness, rutting and faulting (Mandli system). Pavement distress collected manually.	In-house	Planning

this discussion, the group identified issues concerning use of pavement condition data for decision making. Then they identified needs to address the cited issues, followed by identification of the good practices for the agencies.

How Pavement Management Is Currently Being Used

All of the participants in the Peer Exchange use the pavement management system to develop project and treatment recommendations. In addition, the information is used to meet reporting requirements for both internal and external stakeholders. Following is a summary of each state's response with respect to this topic.

Illinois

Illinois has used their pavement management system to track performance over time and to identify which pavements require maintenance now, will require maintenance within 5 years, and are acceptable (will not require maintenance within 5 years). They use a scale of 1-9 to identify or classify the different levels of pavement condition.

Kansas

Kansas has tried predictive data in performance measures and got "push-back" from upper management. They have determined that performance measures need to be VERY defensible if they are to be used. However, KDOT currently uses their PMS for all types of decision making including strategy selection, predicting future resource needs, and the like.

Michigan

Michigan DOT also has been using pavement management for a number of years to support decision making. They are considering moving away from reporting Remaining Service Life (RSL) to the public because the public has a difficult time understanding the concept. A survey was completed a few years ago and showed the public more closely associated the sufficiency rating with

the public's rating of the condition of the roads. In the future, the state may report surface condition windshield survey data (1-5 scale).

Nebraska

NDOR currently uses the Nebraska Serviceability Index (NSI) to characterize road surface condition on a scale of 0-100. The NSI gauges the health of the network and is used to identify needs for pavement preservation and other facilities. With the pavement management system they also select pavement strategies and predict future performance.

North Dakota

NDDOT uses the Deighton pavement management system, dTims, for developing network condition, strategy selection, and priorities for the districts. The results are used by the Districts for making project level decisions and by upper management to convince the legislature of funding needs.

South Dakota

South Dakota has been using pavement management systems for a long time. Their upper management is very supportive of the system, but there is still some resistance to using the pavement management data in the regions. In order for people to accept the output of the pavement management system, they need to understand it. It should be marketed in a manner that is understandable and defensible.

Wisconsin

WISDOT uses their data to make decisions on strategy selection, determining the life extension of the various treatments, and predicting future pavement condition so they can answer the "what if" questions.

ISSUES IDENTIFIED

The various state participants identified the major issues facing them with respect to this topic. This included items such as:

- Data adequacy and accuracy is difficult to quantify and measure.
- Use of pavement condition data for performance measures still has some problems.
- General acceptance of pavement management is still lacking in some agencies.
- The project and treatment selection process is still a work in progress.
- Agencies must have a champion to keep the system working.
- Pavement management has a changing definition between people. It is more than just data collection.
- The credibility of the person presenting the data is very important. He/she needs to be passionate and a good communicator. In other words, he/she needs to be a good salesman.
- Are the systems too complex? Do we need to educate decision makers more?

It was generally considered that training is needed for upper management to explain how these data are useful.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

Several needs were identified to address the issues raised above:

- Performance prediction – decision-makers need to understand the quality and limitations of the models used for prediction.
- Performance measures – agencies need to establish goals, but also be careful as funding can be affected if the goals are met or not.
- Solutions from pavement management go back to best-value fix. Agencies need to focus on what is the best-value (e.g. the least cost per year of service life extension).
- Rehabilitation still needs to be part of pavement management in order to take care of bad roads. However, pavement preservation provides the highest value fix in most cases.
- Automated data collection needs to be handled carefully because there are some things that are not going to be easily categorized (e.g. durability, load, and environmental related distresses).

- In terms of automated data collection, many states indicated they need to live with what they have for a while. Some automated procedures provide a general measure as to how much cracking there is, but automated distress identification is not accurate or consistent enough to provide information to identify what to do about it.

- Some decision makers do not believe it takes more money to rehabilitate a roadway in poor condition. Education is a key.

- Funding from FHWA has been boom or bust. Highway authorization bills don't lend themselves to maintaining highways in good condition over time.

HIGHLIGHTED PRACTICES

Each agency was asked to highlight their best practices in this area. Following are the responses:

Illinois

- They have established performance measurements between district / central offices / executive IDOT, and legislators / government office.
- District (non-centralized) decisions for maintenance treatments are used in Illinois.

Kansas

- A process is in place to take PMS recommendations to action.
- PMS recommends the miles of preservation work per district, candidate projects, location and the tentative scope of the project.
- The Districts select (with constraints) project locations to meet mileage and scope.
- All projects are reviewed in terms of both location and scope by 3 wise men (M&R, C&M, and District).

Michigan

- PaveMaPP. This is the in-house software for automated development of remaining service life (RSL) along with other data management.
- Development of pavement performance curves.
- Distress Identification from Pathways – looking at simplification of distress point matrix and possible sampling for collection of data.
- Road Quality Forecasting System (RQFS) – This includes the use of predictive models to identify funding needs under various condition goals based on RSL. This was most recently used with Transportation Funding Task Force (TF2).

Nebraska

- Allocations. Nebraska feels the method used to allocate funds to each district is a best practice.
- Pavement preservation. They focus on pavement preservation as the highest priority for treatments.
- Interstate Task Force. This task force makes all the decisions on projects for the Interstates.

North Dakota

- The highway pavement classification system used by NDDOT is legislatively endorsed.
- Common terminology has been developed for all pavement discussions.
- A tiered approach to managing the system has been developed and is used.
- They use ride, distress, and load to help make decisions.

South Dakota

- The involvement and support of upper management with reporting and with the results of the analysis.
- The identification and training of "Champions" that understand the data and what it means.

Wisconsin

- Scope compliance-program effectiveness. The measure of approximately 80 percent match is a best practice.
- Viable improvement options. WISDOT develops both a best value and a low cost option.

CHAPTER 3

Using Pavement Management for Short- and Long-Term Planning

TOPIC SUMMARY

This topic covers the methods used for short- and long-term planning. The participants defined short-term planning as less than five years and long-term planning as greater than five years. The agencies first discussed their current practices then covered some of the issues and needs associated with the topic. A list of best practices was also developed.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

The current practices among the various states are summarized below:

Illinois

The primary use of pavement management data is in preparation of a one year and six year highway improvement program. The system provides funding targets based on physical condition data along with other information. The system provides guidelines for districts based on traffic, pavement condition, and funding categories to prioritize projects. It should be noted that the Chicago district gets about half of the budget. Otherwise, the state tries to provide funding consistency between districts for the overall program. Program information is shared at all levels of the government. It allows one to identify goals. The six year program is on the IDOT website and includes funding targets and guides to districts.

Kansas

Short-term – the pavement management system is used to provide candidate project locations for two, three, and four year time horizons. The districts decide on specific projects with guidance from central office.

Long-term – A priority formula process is used that includes pavement condition, geometry, and capacity. For very long time horizons (twenty years), the system is used for developing funding programs. The state runs the PMS in steady-state mode to identify the cost to maintain or achieve desired pavement conditions.

Michigan

Short-term - Michigan develops a five year plan which is submitted annually. They allocate funding to all programs based on the overall goal and pavement condition. Once funding is identified, they allocate funds to each region. Currently, they report remaining service life (RSL) and surface condition within each region. A review is conducted annually to identify if updates are needed to the RSL Value. The allocated money is provided to the region for the Road – Rehabilitation and Replacement and Road – Capital Preventive Maintenance Templates and then they decide how to spend the funding. Within each region, MDOT identifies a minimum distress index (DI), IRI, RSL and rut for each kind of fix for the Capital Preventive Maintenance Template (CPM). For road replacement and rehabilitation, MDOT looks at RSL.

A total of 26 Transportation Service Centers (TSC) within the state assist with this effort. MDOT also works with metropolitan planning organizations (MPOs) in the state. Once candidate projects are identified, the Regions work with the TSCs to select projects and provide the results to the region office. Region offices submit these to the central office for review. The Regions use performance data when projects are developed. When the projects are submitted in the Five Year Call for Projects, project locations are reviewed for IRI, RSL, DI and rutting to determine if the projects that are selected meet guidelines and statewide strategies.

Long-term (twenty year) - This report is produced for policy level decision making. It identifies revenue needs and performance measures to focus on and goals for the next twenty years. It includes revenue forecasts, revenue gaps, and addresses the “what-if” questions.

Nebraska

Short-term – NDOR runs an analysis using pavement management data through the Pavement Optimization

Program (POP) ten year analysis routine. It provides the districts with five or six years of potential projects. The District Engineers use this information as part of their decision making process. The state uses this program on an annual basis (pavement preservation is the highest priority). The overall network condition is currently 84.7 (using the Nebraska Serviceability Index - NSI). The Department's goal is to maintain the system at its 84.7 average.

Long-term - The state performs a ten year analysis on an annual basis to see how much money is required to achieve or maintain the NSI of 84.7. The Districts are provided maps of NSI projects. The POP program is also used to develop a policy document for long-term system needs. This twenty year needs assessment is presented to the legislature on an annual basis.

North Dakota

Short-term - The state field reviews projects annually and uses pavement management results for discussions with the district engineers as to what works and what doesn't work. Those results are used for short-term use in pavement management analysis for project selection. District engineers use these results to set priorities and send their list of project priorities to the State Transportation Improvement Program (STIP) programming engineer. The central office provides budgets to district engineers based on the STIP to allow them to prioritize projects.

Long-term - The state uses network level results for reports to the legislature. These are bought into and endorsed. A system level review of where network conditions are and where they are headed is included in this report. It is also used for Highway Performance Monitoring System (HPMS) reporting and for answering the important "what-if" scenarios.

South Dakota

Short-term – The state uses a three year plan for resurfacings and rehabilitations on all pavement types and a five year plan for reconstruction. The state has very little rural reconstruction (one or two a year). In the short-term the state uses its pavement preservation program - rout and seal, chip seal, and joint repair. SDDOT has always had rout and seal and chip seal projects every year. The state conducts inspection trips to review projects selected by the districts.

Long-term – "What-if" scenarios are requested and provide support to upper management. Recently, the long range plan was updated (twenty year). The state has also updated its performance models, but the amount of data (large dataset) is making it difficult to get thorough data to support that effort. The state is pondering a review of how the performance curves are updated so that they can be reviewed more often.

Wisconsin

Short-term – The state programs projects using an Asset Management approach. The state's Asset Management system is termed "Meta-Manager". Meta-Manager incorporates all needs under one umbrella. For the Backbone system (Interstate and major US and state highways), a statewide Backbone Committee guides Backbone programming. The Committee is chaired by the Bureau of State Highway Programs Director, who is responsible for Asset Management. For the non-backbone network, funds are allocated to the regions to manage their program. Currently a 7.5 year program is developed for Backbone and a six year balanced program is developed for non-Backbone.

Long-term (> six years) - Long term statewide planning is conducted by the Bureau of State Highway Programs. Again, state needs are determined in a holistic sense incorporating pavement as well as other assets.

ISSUES IDENTIFIED

The issues raised by the various states on this topic included the following:

- Not enough funding is available to do an adequate job managing pavements.
- Are decision makers considering both short-term and long-term policy decisions? One state remarked that they were and thus the reason for the focus on pavement preservation. However other states thought that the legislature only looked at short-term issues.
- Education – there is a need to visit regions to teach universal language and the fundamentals of pavement management.
- The cost associated with implementing new technology is very high.

- There is a need to have a departmental champion at a pretty high level.
- For one state, the inertia of the system works against them. For example, if the pavement system doesn't degrade in performance then decision makers decide that pavements don't need more funding.
- The public has a hard time understanding trade-offs of budget versus performance. For example, if the budget is decreased one year then this affects future performance, however performance declines are delayed. It is very difficult to justify increased funding.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

What do we need to improve short- and long-term planning? The following items were mentioned by the attendees:

- Additional funding to preserve pavements and enhance pavement management.
- Communication or marketing so that stakeholders understand the concepts, strengths, and weaknesses of pavement management.
- Staffing. The states want to preserve expertise at DOT as they have to work internally to provide the results. States also need data collection expertise within the agency for developing statements of work for vendors and performing quality control (QC) on the data collected.
- Customer involvement was another key topic of discussion. Many states expressed an opinion that stakeholders need to be educated so that decisions can be justified and discussed in a transparent manner.
- The states also expressed a need for better performance models to drive the short and long-term planning forecasts.

HIGHLIGHTED PRACTICES

Each of the participating agencies was asked to provide a summary of their good practices. The good practices identified by the group as a whole on this topic are summarized as follows:

Short-term (< five years) – Generally the states were in agreement that their short-term practices are working fairly effectively. Having a system that can track performance and justify project selection is a key. Having a system that can provide information on project selection, priorities, resource allocation, etc. is another strong feature of the states' pavement management systems.

Long-term (> five years) – most states view the long-term plans as policy documents. While the long-term plans are hampered in some cases by the accuracy of the performance models, pavement management provides a framework for developing these long range plans. It was noted that the accuracy of the prediction models for development of long range plans is poor at best.

CHAPTER 4

Establishing Links with Pavement Preservation and Maintenance Operations

TOPIC SUMMARY

This chapter summarizes the discussion from the Peer Exchange on links between pavement management, pavement preservation, and maintenance and operations.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

After introducing the topic to the participating agencies, each agency was provided the opportunity to present information on the links between the various programs and to indicate areas that may need improvement.

Illinois

Illinois DOT identified several links between the various groups. For years, the state has been applying Surface Maintenance At the Right Time (SMART) overlays / surface maintenance at the right times. Preventive maintenance is fairly new on the state system as it started in 2005. This was prompted by an industry group who asked to do demonstration projects. The state is trying to start a policy on these using a limited number of treatments such as cape seal, chip seal, slurry seal, and microsurfacing. Each district is supposed to use ~$1M per year on these treatments for a statewide total of $8M per year. The state uses a manual which provides guidelines on allowable distresses and ADT levels for different pavement preservation treatment types. This manual is still in draft stage, but it's a good document with a lot of information. The Bureau of Local Roads has a pavement preservation manual as well.

Currently, routine maintenance is tracked through the Maintenance Management Information System (MMIS). The MMIS tracks quantities, but not performance. The PMS tracks performance, but does not necessarily know where the treatments are located.

The state has no performance models on pavement preservation treatments at this time. They collect data using their Condition Rating Survey (CRS) and are tracking performance.

Some of the issues faced with pavement preservation are as follow:

- Eighty percent of the pavement system is PCC or composite. These pavements are not the most appropriate candidates for the types of preventive maintenance treatments used by IDOT and the state has some issues with reflective cracking.
- Quality of workmanship with pavement preservation treatments is a concern for IDOT. The state only has two contractors that perform pavement preservation. Even when the proper treatment is selected, the construction has sometimes been poor and the agency has received complaints. The agency is looking at providing additional training on methods to QC preservation treatments.

Kansas

KDOT has had a PMS for a long time and it considers preventive maintenance treatments. The state has tried many different treatments, but performance information is still lacking on concrete treatments. The system provides suggested scopes for treatments – ranging from chip seal, rout and crack seals, to some thin HMA overlays. All suggested treatments are provided to the districts and then reviewed based on local knowledge to determine what is appropriate. There is then a further field inspection once a project and treatment is selected by the districts to make sure it is appropriate. The "three wise men" - Bureau Chief of Materials, Chief of Construction, and the District Engineer review these projects. KDOT has had a change in the three wise men with new individuals in these positions. They believe in the process, but they are a new generation. A change of

champions is a significant issue and it can affect the performance of the program.

Within the pavement program, the state has $600,000 to $1M for each district for preventive maintenance treatments. This funding is usually allocated outside the normal pavement program project selection because a two year program (from project selection to construction) is too long a period to select and execute preventive maintenance treatments effectively. Almost all the funds are spent on chip seals and rout and crack seal. The performance models are built on the assumption of routine maintenance being performed – potholes filled, patching performed, etc. The preventive maintenance report developed by the PMS is pretty good at predicting the needed amount of pavement preservation from a state-level or district-level perspective for planning but it is not as realistic in identifying specific locations for preventive maintenance and the preventive maintenance list is not distributed anymore.

Kansas does not predict preventive maintenance performance or life extension as the agency does not leave anything alone long enough to find out what life extension is achieved.

The agency mentioned that linking back to the location and treatment type is not a simple process. They mentioned that if the work was performed by a contractor it is easier to determine treatment and location because the activity is documented a little better (for contractual purposes) than if state forces perform the work. KDOT now develops a report for maintenance to update as they do their pavement maintenance work.

Kansas also provides PMS data to the Turnpike Authority that uses it to make decisions.

Michigan

MDOT has a $90M capital preventive maintenance program (CPM). Any savings on snowplowing is used for maintenance projects. The state has a CPM engineer who is a "go between" for industry and the state. Each region has a pavement engineer who coordinates the selection of projects for their region based on the CPM Template Target. MDOT has a target for pavement sealing and functional enhancements. MDOT now requires warrantees on all capital preventive maintenance (CPM) projects. Each TSC has a delivery engineer that reviews the projects. MDOT has a warranty database that provides output on the inspection before the warranty expires.

MDOT captures treatments in a database which includes where, what, and the cost which is linked to the PMS. There are criteria for each type of fix that describes the minimum pavement criteria including distress index, RSL, rut depth, and IRI. These criteria are used to determine if the treatment is suitable.

To implement projects, the Region and TSCs perform an on-site project review in their area to identify potential projects and appropriate pavement fixes. Central Office reviews locations. The state has performance curves for some of the treatments.

Nebraska

NDOR has always had a maintenance program including crack seals, armor coats, and microsurfacing. The state has a fairly sophisticated maintenance manual which can be found on their website. Preventive and reactive maintenance are covered in the manual. The maintenance manual is very thorough concerning identifying when to perform a specific treatment. This manual also contains information on the PMS and how some of the PMS performance criteria are determined.

For Nebraska, the PMS provides categories of treatments and not a specific treatment. The categories are developed using the Pavement Optimization Program (POP). The state runs all of the data through the POP decision trees which results in the category of work needed – maintenance level 1, 2, 3 or resurfacing for a particular roadway. The overall budget and cost-benefit ratio is used to identify potential projects.

A ten year analysis is performed and the results provided to the districts. The districts have a lot of control in reviewing and selecting specific projects so the list generated by the PMS is a suggestion. Currently, the district uses the PMS recommendations 70 percent of the time. A different project level strategy may be selected based on practical factors such as manpower, economies of scale, etc. Buy-in from the districts on using the results of the PMS has increased over the years.

There are eight districts in the state and some have embraced preventive maintenance more than others. The Department as a whole has embraced pavement preservation, but as money starts to dry up, maintenance

may lose out and more emphasis may be placed on trying to take care of some of the big problems.

North Dakota

The state has embraced preventive maintenance. Chip seal, slurry seal, microsurfacing, and thin overlay are used as preventive maintenance treatments for asphalt pavements. Concrete pavement restoration (CPR) is used on concrete. The use of chip seals is based on timing. Three years after an overlay, the state automatically does a chip seal. Districts are allowed to make a determination as to whether it is three years or sooner. Chip seals are now being programmed through the State Transportation Improvement Program (STIP). The state uses slurry seals where chip loss is an issue. An ADT of 2,000 is the upper limit guideline for chip seals.

At the network level, the PMS identifies categories of treatments, not a specific treatment. The districts have the opportunity to identify what treatment should ultimately be used.

Performance models are based on historical data so the benefits of preventive maintenance are captured. The state cannot identify the life extension associated with a chip seal because they don't have the performance data for sections without a chip seal.

The state does not have a true maintenance connection with PMS. They are working on trying to get stakeholder groups together to develop a true maintenance management system.

South Dakota

SDDOT has always had a preventive maintenance plan, especially on initial construction. It was not included in the PMS until recently. Now, treatments for chip seals, rout/seals and microsurfacings are all programmed through the PMS. This has been in place for two to three years.

The state has a maintenance manual (borrowed from Illinois) that was revised to be more applicable to SDDOT operations. The manual describes when treatments are appropriate based on distress and expected life. This is a working document for area engineers. The PMS section had input into the document's creation.

Recently, it has been proposed to create a full-time position to handle preventive maintenance. This position will be on the operations side, but will coordinate with the pavement management section. The position has not been approved by upper management yet.

Currently rout and seal and chip seal treatments are planned activities (initial treatment). Subsequent applications are based on distress. Fatigue and transverse cracking are primary triggers for these treatments.

As an example of the benefits of preventative maintenance, the state has a 20-mile segment of roadway covering 2 regions. One region chip sealed and the other did not. The chip sealed section has performed well while the other section is now programmed for mill and overlay.

Wisconsin

Wisconsin has a long history of pavement management with over 30 years of performance modeling. WISDOT has recently converted to the Pavement Condition Index system to provide a robust index and detailed distress identification and measurement procedures.

Currently, the PMS does not link to the Maintenance Management System. Highway maintenance is run by a different bureau. The Legislature currently provides separate budget appropriations for highway maintenance and improvement.

WISDOT allows pavement preservation and preventive maintenance projects to use improvement funding when a 4 or 5 year life extension is calculated.

ISSUES IDENTIFIED

As a group, the state identified issues which they face related to the link between PMS and preventive maintenance. The following is the list of issues identified (not listed in order of importance).

- Not every state has a direct link between PMS and the maintenance management system. Where the link exists, it is very weak.
- Not knowing where maintenance is performed creates major problems for the PMS.
- Life extension – some states can determine this, but others can not.

- Agencies tend to think of pavements as black, white, or black over white and don't know how performance works on built-up or composite pavements. Pavements are not just black or white. There are many categories which can be difficult to model.

- Some states are not willing to try new maintenance activities such as in-place recycling. Implementing new technologies can create challenges. The number of models required to track performance of the full variety of treatments is causing problems with data storage and increasing the complexity of the system.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

To address the issues noted above, the Peer Exchange participants identified a number of needs in this area, some of which would make good research projects.

- Links to the maintenance management system and/or maintenance need to be improved so that treatment type and treatment location can be determined. This will assist with development of improved models.

- Good models are needed for all of the different treatments available today.

- A change in culture between field maintenance personnel and the central office must be nurtured so that each understands the others' needs and thereby each group can mutually benefit from each other.

- There is a need for more QC guidelines for pavement preservation. The states need some assurance that the treatments are being constructed properly.

HIGHLIGHTED PRACTICES

Each of the participating agencies was asked to identify good practices for the entire group. Here is a list of the good practices identified.

- Most of the agencies do have some sort of link between the pavement management system and pavement preservation. Pavement preservation strategies are a high priority in most states.

- Common metric - life extension is being applied to pavement preservation treatments and improvement programs. This forms the basis for a common comparison of treatments.

CHAPTER 5

Developing Performance Models and Performance Measures Using Pavement Condition Information

TOPIC SUMMARY

One of the most difficult tasks in a pavement management system is to develop reasonable performance curves for individual treatments or families of treatments. Most agencies use either deterministic or probabilistic models to predict pavement deterioration. Probabilistic models predict the likelihood that a certain level of performance will be achieved and rely on probability matrices to quantify the probability of each possible result. More commonly, agencies are using deterministic models to predict the condition as a function of time or age of the pavement. Some agencies use a family modeling approach in which various treatments are grouped into one family and a prediction curve developed for the family.

Performance measures, such as a minimum ride score or distress index, were also covered. Most agencies have a minimum score that they would like to maintain for the network ride or condition.

This chapter addresses the issues of developing performance models and performance measures using pavement condition data. The various states provided an overview of their current practices in this effort. Afterward, they discussed some of the important issues and needs, followed by a short presentation on best practices.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

Current practice in this area varies considerably since most of the agencies are using different pavement management systems. This section describes current practices in each state for establishing performance models and performance measures.

Illinois

Illinois DOT has both performance models and performance measures as summarized below:

- Performance models. The models used in Illinois are based on a pavement condition index (PCI). The pavement data are collected, images reviewed, and the five predominant distresses are entered in an algorithm and this number is used to predict performance. They use deduct values based on historical performance, route type, pavement type, age, and presence of particular distresses. Also, they have models for determining whether a pavement is in an acceptable, accruing, or backlog category. All of these categories are driven by condition index. Most of the pavements start at 9.0 and the condition is deducted from this point. The state is evaluating the need for improved models.
- Performance measures – the state has an internal rating system to determine the CRS with a value between 1 and 9. These numbers are presented to the legislature and are based on backlog, or needs, for the road. IDOT has an internal metric, but performance measures are based on needs and these are published.

Kansas

The Kansas system for developing models and measures is summarized below:

- Performance models – KDOT originally created their prediction models using expert opinion. As the field data accumulated, the data driven performance models matched the expert derived models remarkably well. KDOT uses equivalent asphalt thickness as part of the modeling process (i.e., hot-in-place-recycling - HIR ~ 75 percent of virgin asphalt thickness – chip seal and slurry seals are 0.5 inch).

This system is used in place of using different models for different treatments. Models for different distresses and output are combined into the index. Other items related to models are given below:

  - When Kansas discusses pavement preservation items, they find chip seals have a life of five to seven years and microsurfacing has a life of five to ten years, therefore Kansas assumes six years for all treatments. Experts have under-estimated remaining life.
  - The Kansas prediction model is a Monte Carlo-based probabilistic model which is still in a developmental stage. As the Mechanistic-Empirical Pavement Design Guide (MEPDG) becomes more useful, it is expected state personnel will become more comfortable with this process.

- Performance measures. KDOT has developed a chart showing the percent good, fair, and poor pavements that is used to communicate condition. The state has had some trouble when tying condition back to actions. When compared to predictions, the actual ratings rose fast - 72 percent pavements in good condition. This level was achieved earlier than expected partly because experts (used to develop the performance prediction models) underestimated life. The state has questioned internally what the public really wants or needs from the road system condition but the answers have been hard to come by. The ultimate goal is to tie the performance measures to a value, or metric, the public can understand. In support of this goal, the state conducted a road rally and used community stakeholders to identify the condition and tried to relate their opinion back to the index.

- Kansas uses different performance measures internally and externally. Kansas statistically modifies their measures based on a moving average to remove some of the variability in the data that is reported to the public. Kansas publicly reports good, fair, or poor on roughness only.

Michigan

The Michigan method for developing performance models and measures is summarized below:

- Performance models. The state's goal in 1997 was to reach 90 percent of the pavements in good or fair condition. This was originally based on RSL, where RSL was broken into categories - 0-2 year RSL is poor and each five year increment is the next category up (3-7-year, 8-12, etc.). Everything beyond two years RSL is rated good. The state uses RSL and the surface condition windshield survey for reporting and monitoring.

- MDOT uses the road quality forecasting system (RQFS) which is based on RSL. The RQFS contains the current pavement condition and allows the state to forecast system condition for thirty years. It is used as a tool to identify if the system is improving. The analysts input budgets and perform the analysis based on differing budgets, either state-wide or by district. The RQFS has been a good tool for communicating to the legislature as well as to upper management. Also, the state is beginning to try and forecast surface condition - windshield survey data - based on transition probabilities. The state has used this same concept on bridges with good results.

- Performance measures. These are on the MDOT internet site and include IRI and the surface sufficiency rating (windshield survey). They are updated each year. Publishing the metrics is a relatively new procedure and they have a public website and brochure. Over the past ten to twelve years, the state has reported condition on RSL. Now that the public understands the IRI and sufficiency rating better, they are reporting this data in addition to RSL. RSL is used internally to make decisions but the public likes the sufficiency rating. There is currently some internal debate whether all of these metrics should be reported.

- Prediction models for local agencies. Michigan's Transportation Asset Management Council (TAMC) is using PASER data for local agencies. They forecast this data based on RoadSoft developed at Michigan Tech. The forecasted condition is not published unless directly requested. Prediction of PASER data is based on mimicking how the RQFS works at the state level.

Nebraska

The Nebraska method for developing performance models and measures is summarized below:

- Performance models. These are contained in the POP program. Different deterioration rates exist for different pavements. In the 80s, the state had a lot of alkali-silica reactivity (ASR) issues with concrete pavements that deteriorated at a different rate than others. The current modeling scheme is a combination of engineering judgment and historical data. The state uses deterministic models.

- Performance measures. Pavement condition and smoothness are the state's performance measures. The state has developed a manual with the percentage of projects let, safety goals, along with performance measures, which is on their publicly available website. NDOR has a goal for pavement condition and another goal for pavement smoothness.

North Dakota

The NDDOT method for developing performance models and measures is summarized below:

- Performance models. NDDOT uses a deterministic model based on historical data. The state has about 80 models for different pavement types, Highway Performance Classification System (HPCS) class, and rehabilitation treatment. To update the models, the state manually reviews the data using a contract with a local university. The state is looking to develop software applications to make it easier to update the models.

- Performance measures. NDDOT has two performance measures - IRI and distress. These are used to report deficient mileage. The report card for pavements is on the agency website. An area needing some work is in the setting of goals. The state currently has internal goals for IRI. The state is currently debating what the goals should be for the different distresses. In this area, North Dakota emphasized that the performance measures should be tied to public needs. For example, what does the public want? What do they need? How do you set appropriate goals? Are the measures the right measures?

South Dakota

The SDDOT method for developing performance models and measures is summarized below:

- Performance models. These are much like the ones used in North Dakota. Both states use the Deighton software. SDDOT has more performance models than North Dakota, which are based on each distress, pavement type, and maintenance or rehabilitation treatment. There are about 150 performance models in the South Dakota system.

- Performance measures. SDDOT has determined a goal and a minimum condition based on the surface condition index (SCI) which is based on a combination of distresses. It is more or less based on functional class, where all classes have different goals and a minimum value. The pavement network condition is the best it has ever been. The state does not anticipate maintaining the goal, but hope to maintain the minimum. SDDOT also provides the legislature a backlog of projects based on the SCI.

Wisconsin

The WISDOT method for developing performance models and measures is summarized below:

- Performance models. The state is working on a new prediction model which is going to be an index related to a model of deterioration. It will benchmark off thresholds for Capital Improvement Projects (CIP) and pavement preservation projects. The state plans to use the index to develop thresholds and to communicate externally more effectively to stakeholders. The state will still evaluate individual distresses to develop needs analysis alternatives, but will forecast pavement deterioration using pavement condition index (PCI) data.

- Performance measures. The most prevalent request is from the legislature asking for the number of miles rehabilitated. Other than that, WISDOT publishes the miles of deficient pavement. Internally, a program effectiveness measure is used to compare a district's program to the Meta-Manager analysis. An 80 percent match is considered good,

ISSUES BEING FACED

As a group, each of the agencies was asked to discuss their major issues with performance models and measures. The following presents a summary of the discussion on these topics:

Performance Models

- Most models are deterministic.
- The Deighton PMS provides 80 to 150 models. It is difficult to keep up with this many models.
- Models must be complex enough to give good results but not so complex so that they can't be sustained. The models need to be sustainable across multiple generations of personnel.
- Determining the effect of a treatment on the rate of deterioration of an index is difficult to ascertain.

Performance Measures

- Ride or distress as performance measures – what is good or bad? How do we know what the right measures are for our customers? Communicating the measures to the public in a comprehensible manner is difficult.
- It is difficult to link what you do and what you report.
- What does it take to maintain the target condition of the network and how do you look at that long-term?

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

The following needs were identified by the group:

- Families of pavement curves – determining the happy medium between families versus individual pavement segments.
- Need a good statistical package when dealing with numerous models.
- How often does a state need to rate their roads? It should be based on rate of deterioration.
- How much investment is needed on the whole network and how do you spend that in terms of projects and how do you explain and defend the results?

HIGHLIGHTED PRACTICES

This section presents a summary of the good practices identified by the participating states.

Performance Models

- There is a shift to using an index as the number one tool. It is much simpler to understand internally and externally.
- Testing the sensitivity of the prioritization processes so that they are realistic and implementable.

Performance Measures

- In the past, the philosophy was to measure then report. Now it is to measure, report, and act.
- In the future – predict, measure, report, and act. This is what a performance model should do.

CHAPTER 6

The Economics of Pavement Management: Cost-Effectiveness and Cost Savings

TOPIC SUMMARY

Over the years, pavement management practitioners have identified a number of benefits associated with use of a pavement management system. These include items such as:

- Ability to document the network condition
- Ability to predict future conditions given a variable budget
- Increased creditability among stakeholders

For the most part the benefits have been difficult to quantify because they are primarily subjective improvements in agency practices. Due to the current economic climate, it is becoming more and more important to quantify these benefits. The benefits should offset the costs of data collection, software development and updates, analysis, and reporting.

This chapter discusses the results of the agencies' discussion on the cost effectiveness of pavement management systems and identifies costs savings associated with the use of the PMS.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

After introducing the topic to the participating agencies, each agency was provided an opportunity to describe the costs associated with existing pavement management activities and prior successes at being able to document the benefits of the system to justify the program.

Illinois

- Cost. IDOT used to perform all pavement management activities with staff, but is now consulting out vehicle and data collection using State Planning and Research (SPR) funds. It costs the state a little more than $700k annually for outside data collection. Other costs include two staff positions for processing, QC, and working with the data collection consultant. The districts review the images so this includes an additional nine positions – none of which are full-time. It should be noted that using a vendor affects the flexibility of having a data collection van available on-call for major events that the state may want to track or capture as they occur.

- Benefits. The Illinois DOT is committed to pavement management and is in the process of updating the pavement design and selection procedures for HMA and jointed plain concrete pavements. The state needs to prove the performance of the pavements through monitoring over an extended period of time so that they can confirm that treatments are performing as planned. Interestingly, industry has lobbied the legislature by recommending that any project that is over $500k in pavement cost shall use a life-cycle cost analysis which considers pavement performance data.

Kansas

- Costs. Costs include software modifications and maintenance, data collection equipment, personnel to collect data and maintain the pavement management information, and technical staff. The cost to provide the PMS was estimated at about $16M over ten years.

- Benefits – The state's yearly pavement budget is $100M and the state assumes that the PMS provides a 1 percent benefit for a savings of $1M. In 1983, the network condition was around 43 percent in good condition. At that time, the state followed a worst-first approach. The state is doing much better now using a mix of fixes approach and pavement preservation.

- Justifying the program. When the state shows the graphic of percent of pavements in good condition, it is noted that pavement management is not the entire reason for the improvement. There have been changes in the attitude of personnel to strive to

improve performance. The state is getting closer to predict, measure, report, and act. It is difficult to justify new technologies without data and the pavement management system allows that to happen. By using the PMS to track performance, KDOT can verify claims of improvement on performance made by vendors to determine if the product is worth the cost.

Michigan

- Cost. MDOT uses federal SPR funds to maintain the PMS, including data collection. The total budget is $2M to $2.5M annually for data collection and analysis. This includes five full-time equivalents (FTE's) for QA/QC and loading data, and 1 to 1.5 FTEs for information technology support. MDOT staff utilized for pavement management not in the unit do not get charged to the pavement management budget.

- Benefits. The system is primarily justified by its ability to perform "what-if" analysis for different funding levels.

- Justifying the system. The reports presented to upper management and to the legislature can answer the "what-if" questions.

Nebraska

- Costs. In 2004/05, a study was performed to determine whether it was more cost effective to collect data in-house or using a consultant. It was deemed in-house data collection was more cost effective. The state has five full-time personnel involved in pavement management. Three collect data, images, and ratings while the other two supervise and perform the analysis. An information technology (IT) person (75 percent time) is used to maintain and update programs.

- Quantifying benefits. NDOR has not performed a detailed benefit-cost analysis of its PMS efforts. However, the state feels that as a result of PMS they are making better decisions. The pavement condition has been improving for a given expenditure until the last few years. Now, the performance measures are declining because of insufficient budget. The state is now using its pavement preservation program to stretch budgets and maintain system performance.

- Justifying the program. The NDOR PMS is accepted based on the information distributed. The state has moved to a preservation mode and a decision has been made not to perform capital improvement projects until pavement preservation is done. The PMS supports and reinforces this strategy providing justification for its existence.

North Dakota

- Cost. North Dakota does not collect current budget figures for its pavement management activities. Like Nebraska, the organization did perform a cost comparison between in-house data collection versus consultant data collection and found in-house data collection to be more cost effective. Currently, they are utilizing two full-time technicians to perform the condition scoring and two engineering positions for analysis and own a Pathways vehicle for data collection.

- Quantifying benefits. NDDOT has not had to do this in a formal matter. By using the pavement management system and working with district engineers, it forces them to look more at the planning and scoping side of work. Better planning equates to better decisions. On the network side, upper management is in full support. No one has questioned the end result and management has always felt the data was beneficial. When asked to appear before the legislature, they have been able to answer those "what if" questions.

South Dakota

- Cost. Currently SDDOT has two full-time FTEs and uses five summer interns. Automated distress is collected under another office and pavement management is the primary user of the data, but there are others. The information technology group maintains the database. A rough estimate of the cost of the PMS is $250k per year.

- Benefits. SDDOT has not been asked to justify the costs of pavement management activities. The group has strong support from upper management in that they can provide information that upper management wants. This includes all the "what-if" scenarios for presentation to the legislature.

- Justifying the costs. Over the past fifteen years, the pavement management group has been lean and has been able to show improvement in overall condition.

The agency is now focusing on preservation of the system.

Wisconsin

- Costs. WISDOT estimates their pavement management activities cost about $750k per year. This includes six full-time and two part-time personnel.

- Benefits. The agency has built a tool that looks at the sensitivity of the program on asset management logic with pavement management being a component. As an example of the benefits of the system, the agency does not allow pavement reconstruction unless it is a critical project. On a recent call for pavement replacement projects, the central office received twenty candidate projects totaling $400M. When the projects were examined, eight remained as reconstruction and the other twelve were deemed more cost-effective for resurfacing. All twenty projects are scheduled for improvement at a cost of $200M. So, with the extra $200M, the state was able to treat much more of the system. This type of analysis could not be performed without the use of the PMS.

- Justification of the program. The above was part of the justification of the program. If you over-scope or under-scope, there is a lost opportunity cost. The state spent the $400M, but covered more miles than originally planned. If the state misses on the scope for just a 1-mile project of rubblize and overlay instead of the much less costly mill and overlay alternative, this alone could justify the cost of the pavement management activities.

ISSUES BEING FACED

Following the presentations, the group identified the issues associated with identifying the costs of the pavement management activities, identifying the benefits of the system, and methods used to justify the system to upper management or the legislature. A summary of the issues raised are as follows:

- The cost of pavement management activities is not clear or easily determined. What does the pavement management system cover and where does the line get drawn? Does data analysis get excluded from cost?

- Most of the agencies were not able to quantify the benefits of the system, but qualitative examples exist everywhere.

- None of the agencies have had to justify the cost of the pavement management activities to upper management or the legislature.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

In order to address the issues identified by the participants, the following needs were suggested:

- If an agency has a strong upper level champion, justifying the costs of the PMS is not needed.

- Need upper level support where people have to go through you and not around you. That is critical for PMS to make a difference in project level decisions.

HIGHLIGHTED PRACTICES

Each of the participating agencies was provided the opportunity to provide information on the costs and benefits of their pavement management activities. Most of them had some idea of the costs of the activities, but few had done anything to document the benefits of the system, primarily because upper management and the legislature get the information they need on the network condition and the “what if “ questions can be answered.

CHAPTER 7

Communicating and Marketing the Effectiveness of Pavement Management Systems

TOPIC SUMMARY

Communicating and marketing the effectiveness of pavement management activities was the topic selected by the participating agencies. This includes communicating and marketing to several stakeholder groups such as upper management, legislators, the public, and others.

CURRENT PRACTICE AMONG PARTICIPATING AGENCIES

Each agency was asked to provide a summary of their current practices on this topic. The following is a summary of their responses.

Illinois

- Communications. Currently, IDOT has information in several different locations. The Intranet provides data on the Condition Rating Survey (CRS), pavement condition, backlog, location of multi-year projects, and location of next year's projects for IDOT personnel use. The intent is to eventually make the information more accessible to others external to the department.
- Marketing pavement management. IDOT has a document called, "For the Record." It identifies accomplishments and other basic information related to significant projects, money spent, etc.

Kansas

- Communications. Pavement management standards are now going through the AASHTO Subcommittee on Materials (SOM) and many pavement management offices are not tied into the SOM. Just two of the seven participating agencies are located in the materials group within their agency. FHWA used to have pavement management webinars. It was mentioned that these should be continued.
- KDOT has successfully communicated why pavement management is important, and because of its success in the agency many people accept this notion. The agency believes it is best to communicate just a piece at a time. The down-side on communication is that the agency's customers don't know how to provide feedback. Also, maintaining continuity within the PMS group is difficult - is it because the system is too complicated?

Michigan

- Communications. Like Kansas, upper management accepts the process. Lately, the agency has been developing performance measures for all modes. A brochure is given to the legislature to document this performance. Recently, a governor's transportation funding task force was created and PMS data was used to identify highway needs with different budget levels. The Director also appears before the State Transportation Commission and the State Legislature to present pavement management data and/or forecasts to give a picture of where the state is headed. The proof is "in the pudding" - updated maps and data show poor conditions (red) getting smaller. The pavement management unit has visited the regions and explained how data are collected, how regions can use data, and what is needed from them.
- Marketing. A five year plan is on the agency public website and available to the public with performance measures and forecasting information. The message is out there, but it is not being fully absorbed by the public.

Nebraska

- Communications. Nebraska conducts seminars and other information dissemination activities to explain pavement management, the tools involved, and how it gets used. The agency has a good champion in the

State Materials and Research Engineer. He has taken the case to the higher levels and makes recommendations to higher executives.

- Marketing. Several techniques are used to market pavement management results including the following:
  - Education. NDOR gives overviews at various meetings and a show-and-tell at conferences.
  - Manuals. NDOR has developed a pavement management and a POP manual which is posted on the website. They also have a maintenance manual with a brief overview of how you can use pavement management to make decisions.

North Dakota

- Communications. Pavement management data is available to anyone in the department. Districts can download and develop reports or maps. The department has a transportation handbook which is available on the website for public consumption.
- Marketing. For internal marketing, the best tool has been good results presented in a timely fashion. Also, a communication and feedback loop with district engineers has been a very useful marketing tool. For example, one district engineer became a pavement management champion to peers in other districts.

South Dakota

- Communications. SDDOT communicates in various ways. First, they have meetings where most of the engineers in the department get together for a presentation on pavement management – how and why things are done. This is performed more than once and is also presented at regional meetings. The material is presented to new supervisors, lead maintenance workers and others to present why it's important to inform the pavement management section when, where and what was done, and why these things are important to the pavement management process. The sessions are also presented to upper management. SDDOT had Deighton perform presentations about what the PMS does and what it is. A SDDOT research project recommended formation of a pavement management task force (cut across areas of DOT) and this resulted in more buy-in and more people who understand what is going on.
- Marketing. Gas and vehicle excise tax initiatives are provided to DOT with very little input by the legislature. The agency produces a fact book which shows various attributes of the state system for pavements, bridges, safety, etc. It includes trends, what has been done, and what is expected. This information is available online.

Wisconsin

- Communications. All asset management data is distributed quarterly. The PMS has all of the analysis options produced. Pavement management and asset management are being pushed deeper into the programming process. The state is in the final stages of refinements to its PMS. On a monthly basis, the Bureau of State Highway Programs Director meets with region managers to discuss Backbone and Major Highway Project programming issues. A Backbone Programming Prioritization scheme was developed that has support from division administrators and region directors. Keeping districts appraised has increased buy-in and the support needed for the PMS. Having good data is a key and putting the data in the hands of the pavement and design engineers is important. Educating the stakeholders on use of the PMS data is also important.
- Marketing. The key is good communication. Demonstrating tangible benefits from asset management is necessary to maintain support.

ISSUES BEING FACED

Currently most of the agencies have reasonably good communication systems; however, there is opportunity for improvement. The following issues or challenges were raised:

- AASHTO situation. The participating agencies were informed that the pavement management activities now fall under the SOM.
- Defining the appropriate level of communication. When is too much data distributed? What needs to be communicated?
- Maintaining the continuity or sustainability of the pavement management system.

- Coping with technology advances. Adaptation – allowing for continuous improvement.
- Continuity of understanding within the industry.

NEEDS TO ENHANCE THE USE OF PAVEMENT MANAGEMENT

In order to address the issues identified by the participants, the following needs were suggested:

- A senior level champion and/or cheerleader is needed.
- Need upper level support where people have to go through you and not around you.

HIGHLIGHTED PRACTICES

Each of the participating agencies was provided the opportunity to provide information on methods of communication or marketing pavement management activities. Most of them had different ways of communicating internally and externally to the stakeholders, but few have efforts underway on marketing the importance of pavement management activities.

CHAPTER 8

Summary

The FHWA sponsored Pavement Management Peer Exchange Workshop provided an excellent forum for pavement management practitioners from seven states to share ideas and to learn from the experience of others. This document summarizes the discussions held at the fourth such Peer Exchange held on August 24-25, 2010 in Madison, Wisconsin. The peer exchange had representatives from the following agencies:

- Illinois Department of Transportation (IDOT)
- Kansas Department of Transportation (KDOT)
- Michigan Department of Transportation (MDOT)
- Nebraska Department of Roads (NDOR)
- North Dakota Department of Transportation (NDDOT)
- South Dakota Department of Transportation (SDDOT)
- Wisconsin Department of Transportation (WISDOT)
- FHWA Division Offices
- FHWA Office of Asset Management

The report presents a summary of the states' practices in each of the following topics:

- Using pavement management data to support decision making
- Using pavement management data for short- and long-term planning
- Establishing links with pavement preservation and maintenance and operations
- Developing performance models and performance measures using pavement condition information
- Economics of pavement management - cost effectiveness and cost savings
- Communicating and marketing the importance of pavement management

The participating states have used different approaches in developing and using their pavement management systems. Some have developed their systems in-house, while others have relied on venders to develop their system. They all use the pavement management system in decision making and to support their needs to upper management and/or the legislature. Most of the states have used their systems for short- and long-term planning and for answering the "what if" questions asked by their management. All of the states have strong links with pavement preservation and rehabilitation groups, but the links with maintenance are not as good. These links need to be strengthened.

All states have performance models for predicting the future condition of the pavement. Some predict an index while others predict distresses. The quality of the predictions is highly dependent on the quality of the data collected. Most states have defined performance measures such as ride or pavement condition index and have goals for each of these measures. The states are doing a reasonably good job of maintaining their targets, despite the decline in funding. This is, in part, due to the heavy reliance on pavement preservation treatments.

The states do not have as good a handle on the costs of operating their pavement management system nor the benefits derived. More work is needed to document clear benefits and to determine the cost effectiveness of the system. Communicating the importance of the pavement management system to all stakeholders is also important. The states have used different messages and methods to communicate this message. There has not been any formal evaluation on effectiveness of these messages.

Finally, all of the states had positive comments on the 2-day Peer Exchange. They felt it was an excellent learning opportunity. Still, there are a number of issues that need to be dealt with including, but not limited to, the following:

- More uniform definitions of good, fair, and poor roads
- Maintain a champion for the system as personnel changes
- Improve the link with maintenance to determine when and where maintenance treatments have been applied
- Develop methods to quantify benefits of pavement management and pavement preservation
- Improve modeling for predicting performance and determine which distress index should be predicted
- Establish meaningful performance measures

APPENDIX A

Background Summaries of Participating State Highway Agencies

ILLINOIS DEPARTMENT OF TRANSPORTATION

Summary Statistics

The Illinois Department of Transportation is responsible for the maintenance and operation of about 16,000 centerline miles of roadway across nine districts. The distribution of the road network is given in Table A-1. The routes are heavily travelled with over 33 billion vehicle miles travelled on the Interstate and 60 billion vehicle miles travelled on state maintained roads. The state also has 12 MPOs. The annual budget for roadway and bridge improvements is about $2.5 billion.

Table A-1. Illinois DOT network distribution

Roadway Category	Centerline Miles
Interstate (Non-toll)	1,890
State maintained roads	16,057
Toll roads	293
State total including locals	140,834

Highway needs are determined as a function of roadway type as given in Table A-2.

Table A-2. Summary of highway needs

Roadway Type	Acceptable	Backlog (needs)
Interstate	88.9%	11.1%
Other Marked	89.7%	10.3%
Unmarked	82.1%	17.9%
Total	88.3%	11.7%

The pavement management group is located in the Planning Section. It works closely with the Materials Section in the implementation of the system. There is a Programming Engineer for each of the nine district offices. They perform the analysis to determine the pavement condition rating within their district.

Pavement Management Background Information

IDOT (in conjunction with ERES Consultants) developed software to model and project network conditions. The software takes into consideration pavement type, functional class, distresses, ride, rutting, and faulting. Outputs are incorporated into IDOT in-house systems to show the health of the network for “show and tell” to the public. The data is integrated with the I-Roads program which is a web-based program containing planning information, ADT, and inventory data based on Bing Maps. Illinois does not have an integrated PMS, but has several applications that are used to help make informed decisions. Currently the output can only be viewed internal to the state, but they hope to open it to others outside the state soon. The pavement condition data is collected by Pathways. IDOT personnel perform the distress identification.

Pavement Management Technical Information

Data Collection

At IDOT, data are collected on an annual basis by Pathways Services, Inc. The vehicle collects images, rutting, IRI, and faulting. The raw data is provided to the agency and IDOT pavement management personnel analyze the results and present the results to the districts for rating. The survey is conducted on the entire Interstate System and on alternating halves of the state for the rest of the system on a yearly basis. The Condition Rating Survey (CRS) is conducted by state personnel. The pavements are rated on a numerical scale covering excellent, good, fair, and poor. IDOT uses the CRS with ADT and functional class for analysis.

GIS files of PMS data are used internally by the districts. The pavement condition rating classifies pavements into three categories as follows:

- Backlog - need improvements now
- Accruing - will be in the backlog within five years
- Adequate - will not be in backlog within five years

The goal is to have 90 percent within the acceptable (Accruing and Adequate) condition.

Performance Modeling

There was no discussion on performance modeling in the opening session. The only thing that is online is the current inventory. IDOT does not have historic information stored in one centralized location.

Perceived Pavement Management Strengths

IDOT has set performance goals for their road network. The goal is to have 90 percent in the acceptable group. Currently, they have about 88 percent acceptable which is close to their target.

Areas of Improvement

The system does not seem to use all the available data being collected. The fact that the historic data is not stored in one place is a limitation of the system.

KANSAS DEPARTMENT OF TRANSPORTATION

Summary Statistics

Kansas Dot is responsible for maintaining 10,000 state centerline miles where the ADT ranges from 20 to over 150,000. Kansas is in the dry-freeze zone and according to the agency is “flatter than a pancake.” The performance of the pavement system has held steady, partly due to the passage of a state funding program called “T-WORKS” (Transportation Works) which was passed in 2010. It provides $4.5 billion for roadway maintenance and rehabilitation.

Pavement Management Background Information

KDOT has collected pavement condition data since the early 1980s. It developed its pavement management system with the aid of a consultant in the early eighties. The system is used to support program development and provide for candidate project listings.

It consists of a tiered approach for project selection as follows:

- Worst-first for new and reconstruction projects
- Optimization approach for pavement preservation. It uses simple plans for all preservation projects.
- Routine maintenance including patching potholes on an as-needed basis

KDOT has an agreement with the 6 districts that allows the districts to make project specific decisions, but doesn’t allow them to stray too far away from the recommendations from the PMS. Essentially, KDOT plans for the future using past data.

Pavement Management Technical Information

Data Collection

KDOT collects and processes roughness, rutting, cracking, and joint distress data in-house using an automated vehicle. The data is collected annually using four data collection vehicles (two have inertial profilers). The state samples five percent of the system to measure distress.

KDOT has attempted to keep the data collection process consistent over time. They have used back correlations to compare prior data when making improvements in the data collection process.

Performance Modeling

KDOT uses a Markovian linear transition probabilities process to predict future conditions. Initially, this was based on expert opinion, but it now relies on performance data only.

Perceived Pavement Management Strengths

The strength of the system used in Kansas is that it has a long history of use. It has identified pavement maintenance and rehabilitation treatments that work and allows for simplified plans for pavement preservation projects. Table A-3 provides a summary of the more widely used treatments.

Table A-3. Frequently used actions (2001-2010)

Miles on Surface	Last Surface Action
1941	Conventional seal
1037	Rout and crack seal
871	1-inch HMA overlay
773	Novachip
741	1.5-inch HMA overlay
521	New construction
494	2-inch HMA overlay
438	1-inch HMA overlay

The budget for surface maintenance is about $135 million per year. The feasible actions contained in the PMS are continuously updated to incorporate new types of treatments.

The system has established performance goals. It is currently 80 percent minimum in good condition and 3-5 percent maximum for bad condition.

Areas of Improvement

Though not discussed in detail, it is apparent that Kansas DOT needs to develop a succession strategy to transition to new leadership in the pavement management section. The system is not easy to explain or to use, but is currently working well. In the event the pavement management leader retires, there could be problems in continuing the effort at the same level.

MICHIGAN DEPARTMENT OF TRANSPORTATION

Summary Statistics

MDOT manages 9650 route miles or 27,440 lane-miles in their state system which handles 48.6 billion annual vehicle miles traveled. The state has 7 regions ranging from urban to rural. The geography consists of rolling hills, rivers, and wetland areas. All the roads are in a freeze-thaw climate. The ADT ranges from 248 (Upper Peninsula) to 203,800 in the Detroit area. The pavement condition measure - remaining service life (RSL) - has increased from 67 percent good/fair to 92 percent good/fair from 1997 to 2007. It is expected to decline to 62 percent by 2015 due to the current lack of investment in the pavement system.

Pavement Management Background Information

Pavement management has been used in MDOT since the 90s. It was first used in 1997 to establish public pavement condition goals and to make a case for a gas tax increases. It is used presently to monitor and forecast system condition, develop an annual call for projects, and demonstrate the impacts of funding conditions on system condition. Other uses of the PMS include project selection, strategy development, pavement design, life cycle cost analysis, pavement forensics, research and investigations, and HPMS reporting.

Michigan is currently using an in-house software called PaveMaPP. It allows for the storage of pavement data and estimates remaining service life (RSL). MDOT has various strategies they use for forecasting future condition. The strategies are reviewed and submitted to a project screening committee who approve the strategies. The forecast of future conditions are based on these strategies.

Pavement Management Technical Information

Data Collection

The condition data collected by MDOT include measures of ride quality and surface condition. Automated vehicles are used to collect the data using lasers and images. Identification of pavement distress is not automated. The state has contracted this work out to Pathways since 2000. About half of the trunk line network is surveyed each year, but IRI is done annually on the NHS to meet the requirements of the HPMS. The data collected includes the longitudinal profile, transverse profile, downward and forward images, all of which are GPS referenced images. From this data, they obtain a distress index (DI), remaining service life (RSL) estimate, roughness, rutting, and faulting.

The distress index is a number representing the surface condition. DI = 0 if there is no distress. DI = 50 equates to a remaining service life of 0. There needs to be a

minimum of three DI values to estimate remaining service life. MDOT also collects sufficiency data of ride quality and surface quality information using manual surveys. These are collected by state personnel annually using a windshield survey. The surface condition is rated on a scale from 1 to 5. Other data collected as a part of the sufficiency survey includes capacity and level of service and changes in attributes on new projects completed within the past two years. This data is disseminated throughout MDOT.

Local agencies and MDOT utilize the PASER rating system to evaluate their federal aid eligible roads. They are rated on a scale of 1-10. They collect PASER data on 50 percent of the federal aid system each year (a total of 38,700 route miles). The PASER system provides a common rating system between MDOT and local roadways.

Performance Modeling

A road quality forecasting system (RQFS) was developed in-house to predict the future condition of the pavement in terms of RSL. It forecasts the distribution of the RSL for the network using a matrix of deterioration curves to forecast the sufficiency rating.

Perceived Pavement Management Strengths

The pavement management system has resulted in permanent funding for pavement preservation. A total of $450 million per year is provided which includes $90 million for preventive maintenance and $360 million for rehabilitation and reconstruction. They have also established a formula to allocate funds between regions and publish an annual five year plan. This has proved useful in implementing the work needed statewide.

Finally, the establishment of the Transportation Asset Management Council (TAMC) in 2007 has been a great help. Team members representing the DOT, cities, counties, townships, and MPOs assist with management of the federal aid local road program. The local agencies use a different pavement rating system (PASER) than the state system and the condition of the locally managed pavements is reported to the State Transportation Commission.

Areas of Improvement

The state did not identify any needed improvements to their system other than the desire to reduce the cost of pavement data collection and automated distress recognition.

NEBRASKA DEPARTMENT OF ROADS

Summary Statistics

Nebraska DOR manages a total of 9,950 centerline miles, of which 8,533 are asphalt concrete and most of the remainder are portand cement concrete pavements. They also have 37 miles of gravel roads. There is a total of 23,000 lane miles within the state system. The pavement management group is located in the Materials and Research Division.

Pavement Management Background Information

The pavement management system used by NDOR includes the following key items:

- Pavement rating system
- Pavement optimization program (POP)
- Output generated by the pavement management system

The pavement condition indices used include the following:

- Nebraska Serviceability Index (NSI)
- AASHTO present serviceability index (PSI)
- International Roughness Index(IRI)
- Cracking index
- Percent bad panels
- Percent repairs

The NSI gauges the health of the network as shown in Table A-4. NDOR has divided the NSI description into five levels.

Table A.4. Categories of NSI

Description	Range of NSI
Very Good	> 90
Good	70-89
Fair	50-69
Poor	30-49
Very Poor	0-29

From this information, NDOR develops a statewide needs assessment annually which includes not only roadway work but work related to bridges, railroad crossings, geometrics and the like.

Pavement Management Technical Information

Data Collection

NDOR uses a Pathways van to do most of the data collection. They have owned their van since 2006. They collect information on roughness, rutting, faulting, and cracking. They use a combination of downward and forward images for high volume roads.

In addition, they conduct a windshield survey each year. They evaluate 200 ft from each mile and use this data to adjust the final ratings. All distresses are rated for extent and severity.

The data is used to develop the NSI which is a measure of the overall health of the network and to determine project size. A map of the pavement condition is developed and distributed based on the NSI.

NDOR also looks at the impact of the budget by year on the condition of the network. Safety is the most important item, followed by finishing the Interstate and keeping the system in its current condition.

Performance Modeling

The POP software is used to monitor the condition of the pavement network and to assist with pavement strategy selection. It is also capable of performing LCCA on the various strategies to determine which one is the most cost effective.

Perceived Pavement Management Strengths

The output of the pavement management system has proved to be a useful tool to get buy-in from the districts. It is considered a corporate measure of the network health with goals of 84 percent of the network in good or fair condition. Nebraska is starting to see a decline in the network condition.

Another useful output from the PMS is a twenty year needs assessment which is reported to the legislature. Pavement preservation is a major budget expenditure consisting of 61 percent of the total budget.

Areas of Improvement

NDOR continues to monitor its performance models and new technology in order to update the PMS. They also survey their customers to identify any additional needs they may have regarding the PMS.

NORTH DAKOTA DEPARTMENT OF TRANSPORTATION

Summary Statistics

North Dakota was the first state to complete its Interstate program and the only state not to have an earthquake. It manages its 8,500 miles of roads with the pavement management unit which is located in the Planning and Programming Division of NDDOT. North Dakota has more miles of road per capita than any other state.

The department is a centralized DOT with 8 district offices. The east part of the state is flat and consists of farm land. It is subject to flooding. The middle part of the state is farm land, but the terrain starts to change. The southwest is rugged terrain and has plateaus. In the northwest, oil production activities are taking a toll on the roads.

Pavement Management Background Information

The pavement management unit has five employees and three main functions including:

- Pavement condition data collection and analysis
- Pavement management analysis
- Project scoping

The state has been collecting pavement condition data since the early 1980s and owned a PaveTech van before it became Pathways. They now own their own Pathways van.

NDDOT uses Deighton software (dTIMS) for its PMS efforts. They have been using this software for about four years.

Pavement Management Technical Information

Data Collection

Pavement data collection is done by a Pathways automated vehicle every year in each direction for the Interstates and in one direction for 2-lane roads. A total of 15,000 lane-miles is done each year. It takes two employees about 3-4 months to collect the data, depending on the weather. Scoring starts in December and is completed around May the following year.

Deducts are assigned for each type of distress and a representative sample of each mile is scored and applied to the entire mile. The distress score is similar to a PCI starting at 100 and reduced by deducts depending on the type, extent, and severity of the distress.

The District Engineers are provided the output of the dTIMS project level analysis annually which includes data and maps. They use the data as a tool in the development of their project priorities.

Two engineers scope all rural projects except for preventive maintenance projects. The Chief Engineer approves the reports and chooses the projects.

Performance Modeling

There were major revisions to the Deighton software, dTIMS, in 2006. The new software now provides network level budgets and condition information for management. Project level recommendations are provided to the District Engineers for priority development. In the past there has been a 70 percent match between the PMS and district personnel recommendations for projects.

Perceived Pavement Management Strengths

The strengths of the PMS are several:

- It prepares yearly reports for upper management including network condition and percent miles in the excellent to good categories.
- It can evaluate the impact of the Statewide Transportation Improvement Program (STIP).
- In 2008, NDDOT created an interactive tool to answer the “what if” questions.

The Chief Engineer is mainly interested in answers to the following questions:

- Assuming funding continues as it has in the past, what will the network condition be?
- What funding is needed to maintain the current network condition?
- What is the impact of the draft STIP on the network condition?

Areas of Improvement

NDOR is continuing to refine dTIMS for pavements. They are adding other assets including bridges.

They also plan to increase the dialog with policy makers and the public on cost versus quality issues and realistic goals for performance measures.

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION

Summary Statistics

SDDOT currently manages about 17,717 lane-miles of pavement. Asphalt concrete pavements constitute about 13,475 lanes miles, Portland cement concrete pavements consist of 3,994 lanes while the remainder are gravel roads. The pavement management system is a centralized system which is housed in the Project Development Office. Most of the population is located in the eastern third of the state.

The pavement network is currently in the best condition ever. A budget of $185 million per year is allocated to pavements. A total of $20 million is directed toward pavement preservation.

Pavement Management Background Information

The pavement management unit, which consists of two people, is responsible for collecting the visual pavement distress, maintaining the pavement management databases which include roadway features, roughness, rutting, and faulting, surface type, maintenance history, traffic and accident data.

Pavement Management Technical Information

The pavement management program began in the 1970s with the collection of data for the roadway environmental system. In 1978, SDDOT developed a highway priority planning file and the first highway needs report was published in 1979.

In 1993, SDDOT initiated the enhancement of their PMS and used it on the Interstate for the first time. The enhanced version was used on the entire system in 1997. After several years of use, they initiated another study to update the system in 2006.

Four items are needed for each project segment. They include:

- Treatment alternatives. SDDOT has nearly 50 treatment alternatives it considers.
- Treatment costs. These include items such as roadway surfacing costs, traffic control, mobilization, and others.
- Treatment triggers. This includes items such as individual distress values, ADT, pavement age, etc.
- Treatment impacts. This includes resetting of individual distress values and calculation of the benefit of the treatment using the area under the index-age curve.

The incremental benefit-cost technique is used to calculate the cost effectiveness of the various strategies.

Data Collection

Currently SDDOT uses automated vehicles to collect roughness, rutting, and faulting. Visually collected pavement data includes pavement distresses for both asphalt and Portland cement concrete pavements. A Pathways van is used to collect the data on an annual basis. Student interns are used to collect pavement distresses from windshield surveys, also on an annual basis. One hundred percent of the roadway network is surveyed each year.

SDDOT collects a lot of data, but needs better QC checks to make sure the data is worth using.

Performance Modeling

Performance curves have been developed for each pavement type. Initially they were done using expert opinion. Additional curves were later developed for each pavement type and distress after a certain rehabilitation treatment. The pavement management system currently has 153 performance curves. The types of curves included in the system include linear, power, cubic, and quadratic.

The independent variables in the functions include the initial condition index, the maximum value of the index, and the pavement age. The index is based on the AASHTO pavement serviceability index, with some changes. The SDDOT surface condition index is homegrown and is based upon a 0-5 scale.

Perceived Pavement Management Strengths

The pavement management system has been used for several years. It is a fairly mature system that is used in the ongoing management of the state's pavement network.

Areas of Improvement

SDDOT needs to implement QC checks on the pavement condition data.

WISCONSIN DEPARTMENT OF TRANSPORTATION

Summary Statistics

Wisconsin DOT currently manages 11,770 centerline miles of state highway pavement. The system stratifies as follows:

- 1,357 miles of the backbone highway program
- 278 miles of the southeast freeway system
- 10,135 miles of the 3R highway system

Pavement management data is used to identify system needs and for funding allocations. All data is distributed to the regions/districts on a quarterly basis and is used for project planning and scoping.

Pavement Management Background Information

The initial pavement management system used by WISDOT was developed over twenty years ago. The current system is now managed centrally and is used to identify system needs and allocate funding. WISDOT continues to make improvements with data collection and schemes for optimization of the network.

Pavement Management Technical Information

The pavement management software used in Wisconsin was developed in-house. Some key priorities established in the system are:

1. Safety
2. Bridge structural adequacy
3. Pavement preservation
4. Bridge preservation

Wisconsin's prioritization scheme also factors in roadway classification (e.g. Interstate/non-Interstate), traffic volume, truck volume, and ride data.

Data Collection

WISDOT collects pavement data for about half of its highways each year, resulting in a complete system condition coverage every two years. Distress data is converted into a pavement condition index and distress analysis is conducted to produce viable improvement alternatives. The data is distributed to the regions on a quarterly basis. WISDOT currently uses 17 distress types for asphalt concrete and 16 for Portland cement concrete.

Performance Modeling

WISDOT is developing performance curves for different pavement types. They use the PCI as the dependent variable and age as the independent variable.

Perceived Pavement Management Strengths

The Wisconsin PMS is a mature system that is used on a consistent basis to make strategic and tactical decisions regarding the management of the pavement network.

Areas of Improvement

Areas of improvement to the system were identified as follows:

- Collecting distress data in a more efficient way without compromising quality.
- Developing a more robust performance measure.