Pavement Management: What Is it? Why Use It?

The "Good Old Days"

For many years people concerned with public works have known that
1. All road surfaces deteriorate over time,
2. It costs less to have good roads than bad roads, and
3. Treating roads while still serviceable prevents or reduces the rate of deterioration.

Into the late 1980s, public works professionals addressed these concerns by focusing on treatments -- techniques, materials, equipments, skills, etc. The dominant decision-making processes, therefore, centered on selection and application of best treatments. Management considerations, such as which road should receive treatment, had little importance because revenues were usually adequate to fund maintenance and repair plans.

A road agent or similarly positioned individual established these plans and budgets by one or more of several approaches.

- **Routine Maintenance.** Established routine maintenance standards; for example, every four years or so seal coating those pavements "due" to receive that treatment.

- **"Worst First."** Priorities established by appearances. Decision-makers gave the highest priorities to the worst looking roads and lowest priorities to the best looking.

- **The Veteran Road Agent.** Reliance on the long-time caretaker of a town's roads and streets. He knew them like his children, and many sought his recommendations even after he was no longer responsible.

These approaches enabled town officials to adjust priorities in response to political considerations. For example, priorities could be easily adjusted for areas that produced many complaints or accidents.

What some might regard as those "Good Old Days" are gone in many locations and fast disappearing in the rest. Municipal budgets on the whole have come under increasing pressure: some road maintenance budgets have stayed at constant levels; most have decreased.

An Emerging Process: Pavement Management

To town officials and citizens alike, more streets appear to become deteriorated each year. Repair costs, on the other hand, seem to increase rapidly. In all too many instances, both perceptions accurately reflect reality.

More and more municipal officials and residents require road agents and public works directors to justify their decisions and their priorities. Many officials and citizens question their road manager's decision-making processes, and increasing numbers insist on use of management processes to help make cost-effective decisions.

Nearly all modern management systems were developed within the theoretical framework derived from a number of studies and illustrated in Figure 1. During the first 40% of deterioration, the pavement performs well. To the untrained eye, it looks good. Once deterioration reaches the level labeled "Fair" in Figure 1, the deterioration rate increases significantly. Indeed, the pavement deteriorates so fast, it seems to fall apart.

As the deterioration rate increases, so also does the cost to renovate. Properly maintained streets, those in "good" to "excellent" condition in Figure 1, require an annual maintenance investment four to five times less than if the pavement is allowed to deteriorate to the "poor" or "failed" conditions and then reconstructed or rehabilitated.

Why does it cost four or five times more to renovate a bad road than a good one? The basic reason is one needs to maintain and repair only the top portion of the good road. For bad or failed roads, one must repair or replace the subbase. Therefore, the optimum time for major pavement maintenance investment is when the deterioration rate begins increasing; that is, when a road is slipping from good to poor condition.

Another way to interpret Figure 1 is in terms of treatment categories. (See the box below for distinctions between these categories.) In these terms, it is better to apply routine and preventive
Levels of Analysis

Scholars and other writers generally classify pavement management processes into “network” and “project” decision levels. Network-level decisions address the road network as a whole; project-level decisions address construction or rehabilitation of a specific part of the network.

Network-level analysis addresses road conditions and the plan to fix them. The primary results are funding needs and prioritized listings of pavement sections for programming maintenance and rehabilitation.

The purpose of project-level analysis is to determine the most cost-effective design and treatment for a given section of road. Such an engineering analysis and design usually involves an expert collecting and analyzing large amounts of data. Because it tends to be much more expensive than network analysis, it is usually applied just to sections which require rehabilitation or reconstruction. These sections are usually identified in a network-level analysis.

In practice, especially in small- or medium-sized towns, the road manager conducts a network-level analysis and consults an engineer or other expert for project level analyses of selected sections. Since the primary concern of local road managers and town officials is network-level analysis, that will be the focus of the remainder of this discussion.

Network-Level Analysis

The stages of a network pavement management system are:

1. An Inventory,
2. Condition Assessment,
3. Repair Strategies and Cost Estimates,
4. Prioritization, and
5. Impact of Funding Decisions.

Inventory. A network inventory defines what is being managed and divides the network into management units. The kind of information gathered is based on the type of roads to be inventoried. The RSMS inventory files include information on road name, its dimensions, and specific characteristic such as number of lanes, surface type, and shoulder type.

Condition Assessment. Road condition assessment defines the condition of each management section and the health of the network. Modern pavement management systems, including RSMS, have specific definitions for pavement deficiencies, and means to quantify the severity and extent of roadway “distresses.”

Repair Strategies and Cost Estimates. After the road condition data has been recorded (usually in a computer), the local road manager’s role changes from observer to analyst. The manager has two tasks: to determine (1) repair strategies appropriate for condition types, and (2) unit-price cost estimate for each strategy. This initial analysis is without regard for what funds will be available.

To take advantage of the pavement management system as a decision making tool, managers should assign several repair strategies for each condition type. This would be especially important for those who use the same techniques year-after-year. What was most cost effective in the past might not be now.

Prioritization and Optimization. Repair strategies are determined without regard to the available funds. In this stage the road manager compares the funds required with the funds available. Within the funding parameters, the road manager identifies the section for repair which will yield the highest return for the available funds. The goal is to provide the greatest overall network condition for the funds expended.

Five Categories of Repair Alternatives

Deferred Maintenance. No action or specific repair to make the road passable. Usually applies when there is no intent to extend the useful life of a road surface.

Routine Maintenance. Patching small areas and general cleaning of the surface, adjacent areas, and structures. For example, patching potholes, crack sealing, ditch and culvert cleaning, and mowing of shoulders and adjacent areas. Usually performed by a municipality’s road crew and included in annual budgets.

Preventive Maintenance. Coating of the surface to prevent or slow further deterioration. Relatively inexpensive repair will enable a pavement to last for many more years. Even those preventive repairs beyond the road crews’ capability should be provided for in annual budgets.

Rehabilitation. Major repairs of the road surface, usually an asphalt overlay after surface preparation. Much more expensive per mile than routine or preventive maintenance, but less than reconstruction. Nearly always performed by contractors, and will likely require a capital improvements plan.

Reconstruction. Repairs which involve excavation of the subbase, the addition and/or stabilization of aggregate, and a new surface. Because the repairs are very expensive and must be performed by contractors, their accomplishment will likely require a capital improvements plan.
Whereas early pavement management systems applied complex "optimization tools," most now use practical ranking systems based primarily on road condition and traffic. Some systems also include the type of service the road provides (e.g., commercial, agricultural, residential, tourism), and the road managers' experience. Users of the RSMS program can prioritize projects by setting percentages for traffic volume, roughness, and road condition.

Impact of Funding Decisions. Few local road managers in New Hampshire have sufficient funds to adequately maintain even the high priority roads. He or she must therefore assess the impact of funding decisions on

- Future network condition,
- Future fund needs,
- Sections with deferred needs, and
- Sections with stop-gap treatments.

Local road managers must, at least annually but often more frequently, convince officials of funding needs. In theory, government agencies attempt to provide the maximum social benefit for the money provided to them by the public. In practice, funds are generally allocated by elected officials who must stand for reelection every two years. Those allocating funds are often more interested in the reconstruction or rehabilitation than routine or preventive maintenance, perhaps because the former show clearer evidence of their actions. Whatever the reason, even though less expensive and more cost effective over the long-term, routine and preventive maintenance generally require considerable justification.

Some users of RSMS have found Figure 1 to be convincing when justifying funding requests. It illustrates the impact of diverting funds from routine and preventive maintenance to reconstruction or rehabilitation of already badly deteriorated pavements. As an RSMS user stated at a recent workshop, it is more cost effective to keep road conditions "above the knee of the curve."

Benefits of Pavement Management

Two benefits dominate the many identified by users of pavement management decision making systems:

- More efficient use of available resources, and
- The ability to justify and secure more funding for pavement maintenance and rehabilitation.

Other benefits include:

- More accurate and accessible information on road systems,
- Evaluation of funding decision impacts,
- Selection of more effective maintenance and rehabilitation strategies, and
- Ability to answer pavement questions from appointed and elected officials.

Cost effective decisions depend on accurate condition assessments. As conditions change, so should the funding and execution plans. Gathering condition data takes time, and road crews and managers often cannot be spared. Subsequent articles provide a data collection alternative for new or revised pavement management plans: UNH civil engineering majors during the summer.

REFERENCES


Editors Note

We wrote this article for a specific target audience: selectpersons, council members, town managers and administrators, and other town officials. In our view they need the basics of pavement management provided above. The referenced sources discuss many other aspects to pavement management. Individual who want additional information, whatever their position, should call the UNH T2Center.

Availability of Pavement Management Software

Private software packages usually require a license for use; public domain does not. The UNH T2Center can furnish information, including reviews, about some private packages, and will search for information about others on request.

The RSMS software package is in the public domain. New Hampshire users can obtain it from the UNH T2Center. Residents of some other states can obtain it from their T2Center. These states also provide training and some technical support.

RSMS is also available through two distributors of transportation-related software packages: (1) McTrans Center for Microcomputers in Transportation and (2) Personal Computing in Transportation (PC-TRANS).

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