Principles of Pavement Preservation

Definitions, Benefits, Issues, and Barriers

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Americans are accustomed to easy mobility on safe, smooth, and well-maintained roads. These same roads play a critical role in the nation's economy, bolstering agriculture, industry, commerce, and recreation.

During the 1990s, the nation's highways experienced a 29 percent increase in use, and more growth is expected in the next 10 years. Large commercial truck traffic increased by nearly 40 percent, with growth projected to continue at more than 3 percent per year during the next 20 years. In addition, more than 95 percent of personal travel is by automobile.

Increasing the capacity of highways, therefore, is important in meeting the nation's needs. But can the United States finance future highway capacity while addressing the needs of the current system? Yes—by developing a strategic plan that includes pavement preservation.

TABLE 1 Public Highway Ownership by Miles

Jurisdiction	Miles (Thousands)	Percentage
Federal	118	3.0
States	775	19.6
Local	3,055	77.4
Total	3,948	100.0

Economical Alternative

Pavement preservation gives highway agencies an economical alternative for addressing pavement needs. Moreover, with pavement preservation, highway agencies gain the ability to improve pavement conditions and extend pavement life and performance without increasing expenditures. The focus is on preserving the pavement asset while maximizing the economic efficiency of the investment. Pavement preservation provides greater value to the highway system and improves the satisfaction of highway users.

Pavement preservation is not about a single treatment, nor is it a one-size-fits-all philosophy. Instead, pavement preservation must be tailored to each highway agency's system needs in the most cost-effective manner. This involves using a variety of treatments and pavement repairs to extend pavement life.

According to the Federal Highway Administration (FHWA), the United States maintains nearly 3.95 million miles of public roads (*1*). Table 1 shows highway mileage by agency ownership. The problem facing highway agencies is that many roads are wearing out because of increased traffic, environmental effects, and a lack of proper maintenance.

Every highway agency must deal with the effects of regional environments on pavement performance, in addition to the effects of traffic. Pavement

sections originally projected to last many years can accumulate distress at an accelerated rate and fail prematurely. Most highway agencies experience and understand this problem but are daunted when budget allocations do not keep pace with the needs of highway pavement upkeep.

Toolbox Approach

In the past, many maintenance practices have not been effective, because they were applied reactively to roads in poor condition instead of proactively to roads still in good condition. Succinctly stated, the correct approach to preventive maintenance is to "place the right treatment on the right road at the right time."

Preservation became a topic in the early 1990s, when highway agencies examined effective maintenance practices. The preservation concept—whether for pavements or for bridges—is a departure from traditional approaches, which wait until deficiencies are evident and until reconstruction or major rehabilitation are the only means to correct the problem.

Preservation, however, addresses minor deficiencies early, before the defects become major problems, and extends the life of the asset at a relatively low cost. A strong preservation program is essential to asset management.

Because preservation activities include so many kinds of treatments, agencies should build their own preservation toolboxes to serve their particular needs. Just as a mechanic's toolbox contains many different tools, each designed for a specific job, a preservation toolbox should include a host of treatments to address specific conditions.

No treatment will be suitable for every location. For example, a chip seal may be a long-lasting, cost-effective surface treatment in a rural area, but not in a large urban area. Conversely, concrete ultrathin whitetopping may be cost-effective in a large urban area, but not in a rural area. Similarly, performance and cost-effectiveness should be evaluated in the context of the areas in which the preservation treatments are applied.

Definitions of Terms

A clear presentation of pavement preservation in the United States requires the development and adoption of standard definitions:

Asset Management

FHWA and the American Association of State Highway and Transportation Officials (AASHTO) define asset management as a systematic process of maintaining, upgrading, and operating physical assets cost-effectively (2). Asset management combines engineering principles with sound business practices and economic theory and provides tools to facilitate an organized, logical approach to decision-making. Asset management provides a framework for both short- and long-range planning.

Load transfer restoration on portland cement concrete pavement: (*left*) cutting a slot in the pavement; (*right*) inserting dowel.

Asset management is important to state and local governments because of the Governmental Accounting Standards Board's (GASB) Policy Statement 34, "Basic Financial Statements for State and Local Governments," issued in June 1999. GASB 34 encourages government agencies to promote asset management practices and to report the value of capital assets such as utilities, roadways, and other infrastructure (3).

The value and maintenance of these assets eventually affects the bond ratings of government agencies, which in turn affect the government's ability to bor-

Microsurfacing on Interstate 75 in Michigan—one of 14 pavement preservation techniques in FHWA's program.

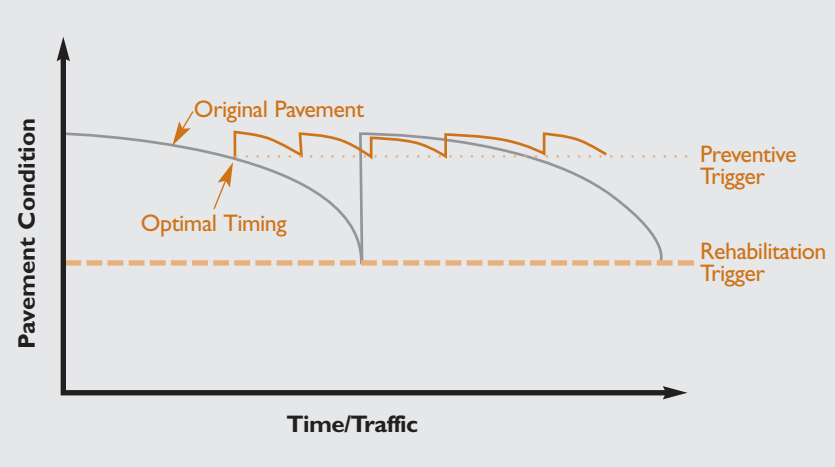

FIGURE 1 Pavement preservation concept.

row the money to repair and replace the investments. The objective of an asset management program, therefore, is to

- Consider various investment strategies,
- Provide a more rational decision process, and
- Improve the overall condition of the highway system at a lower cost.

Preventive Maintenance

According to AASHTO, preventive maintenance is a planned strategy of cost-effective treatments that preserves and maintains or improves a roadway system and its appurtenances and retards deterioration, but without substantially increasing structural capacity (3). Preventive maintenance is a tool for pavement preservation—nonstructural treatments are applied early in the life of a pavement to prevent deterioration. In other words, preventive maintenance applies the right treatment to the right pavement at the right time.

Pavement Preservation

Pavement preservation is the sum of all the activities to provide and maintain serviceable roadways, including corrective and preventive maintenance, as well as minor rehabilitation. The strategy does not include new pavements or pavements that require major rehabilitation or reconstruction.

A pavement preservation program aims at preserving investment in the pavement network, extending pavement life, enhancing pavement performance, ensuring cost-effectiveness, and reducing user delays. In short, the goal is to meet customer needs.

Reactive Maintenance

Reactive maintenance comprises activities that respond to conditions beyond an agency's control—activities such as pothole patching, rut filling, or unplugging drainage facilities. Reactive maintenance, therefore, is unscheduled; sometimes immediate response is necessary, to avoid serious consequences.

Emergency Maintenance

Extreme conditions, when life and property are at risk, require emergency maintenance. Examples include washouts, rigid pavement blowups (the shattering or upward buckling of concrete slabs along a joint), and rockslides or earthslides.

Establishing Values

Understanding the costs and benefits of pavement preservation is important because the nation's highway system has matured—that is, the system has begun to deteriorate. Preservation requires a customer-focused program to provide and maintain serviceable roadways cost-effectively, encompassing preventive and corrective maintenance, as well as minor rehabilitation (Figure 1).

The concept is gaining acceptance—initiatives in the business arena also are focusing on asset preservation, like the GASB policy emphasizing the preservation of infrastructure. GASB establishes requirements for the

TABLE 2 Traditional Alternative: Project Life Cycle Cost

ACTIVITY	D.I. (Before)	D.I. (After)	AGE	LIFE EXTENDED (Years)	R.S.L. (Years)	COST (Lane-Mile)	COMMENTS
New Construction		0	0		25	$ 508,000 $ 21,000	Construction cost User cost
Major Reconstruction	51	0	25		25	$ 490,000 $ 19,000	Construction cost User cost
Total						$ 998,000 $ 40,000	Construction cost User cost

D.I. = distress index, a measure of pavement condition. Scale values: 0 = no distress, 50 = reconstruction required.
R.S.L. = remaining service life, the remaining time in which a pavement can be preserved.

annual financial reports of state and local governments. Since June 1999, GASB 34 has required state and local agencies to provide more specific information in annual financial statements, following the model of the reports by private-sector companies and governmental utilities.

GASB recommends that state, county, and city government agencies apply historical costs to establish values for the transportation infrastructure. Agencies must identify the annual cost of maintaining and preserving the infrastructure assets at—or above—an established condition level. Pavement preservation, therefore, becomes integral to investment decision-making at highway agencies.

Chip sealing protects new pavements, increases macrotexture, and prolongs the life of structurally sound pavements that show surface distress.

Describing the Benefits

The benefits of implementing a pavement preservation program are not immediate and dramatic but accrue over time. Roads that generally are in good condition do not register a major change in condition rating after a treatment is applied—the rating continues as good. What is important, however, is the condition rating several years later—roads that receive preservation treatments are in better condition than those left without treatments.

A comparison of the project life-cycle costs of identical pavement sections with and without treatments illustrates the benefits of pavement preservation. In the example of a traditional alternative, shown in Table 2, a highway is constructed for $508,000 per lane-mile to last 25 years without any preservation activity. After 25 years, the highway must be completely reconstructed at a cost of $490,000 per lane-mile.

In the preservation alternative, shown in Table 3, a highway is constructed with a 25-year design life, also at a cost of $508,000 per lane-mile. After 5 years, the first short-term preservation action is performed for $15,000 per lane-mile, extending the pavement life 2 years. A second preservation is applied 10 years after initial construction—a different treatment that costs $39,500 per lane-mile but that extends the pavement life an additional 8

TABLE 3 Preservation Alternative: Project Life Cycle Cost

ACTIVITY	D.I. (Before)	D.I. (After)	AGE	LIFE EXTENDED (Years)	R.S.L. (Years)	COST (Lane-Mile)	COMMENTS
New Construction		0	0		25	$ 508,000 $ 21,000	Construction cost User cost
First Preservation	11	6	5	2	22	$ 15,000 $ 350	Construction cost User cost
Second Preservation	21	0	10	8	25	$ 39,500 $ 350	Construction cost User cost
Third Preservation	16	8	14	1	22	$ 15,000 $ 350	Construction cost User cost
Fourth Preservation	33	0	20	5	21	$ 55,500 $ 700	Construction cost User cost
Fifth Preservation	14	7	25	2	18	$ 15,000 $ 350	Construction cost User cost
Total						$ 648,000 $ 23,100	Construction cost User cost

D.I. = distress index, a measure of pavement condition. Scale values: 0 = no distress, 50 = reconstruction required.
R.S.L. = remaining service life, the remaining time in which a pavement can be preserved.

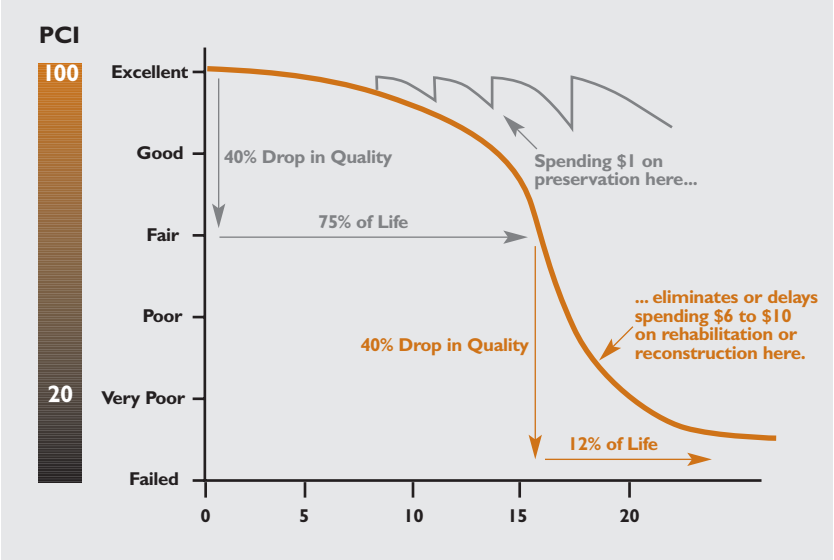

FIGURE 2 Pavement option curve (example). (PCI = Pavement Condition Index.)

years. A third preservation is applied in Year 14, a fourth in Year 20, and another in Year 25.

The preservation alternative offers potential savings in construction. In the traditional alternative, the pavement must be completely reconstructed after 25 years at a cost of $490,000 per lane-mile to extend the expected service life another 25 years. In contrast, preservation treatments cost $140,000 per lane-mile over 25 years and extend the expected service life another 18 years. Moreover, if the deterioration rate does not accelerate, pavement preservation can continue for more cycles, assuming that the pavement was designed and constructed properly.

Considering the user costs shown in the tables, additional savings will accrue. As shown in Figure 2, substantial savings can accrue with a well-planned pavement preservation program.

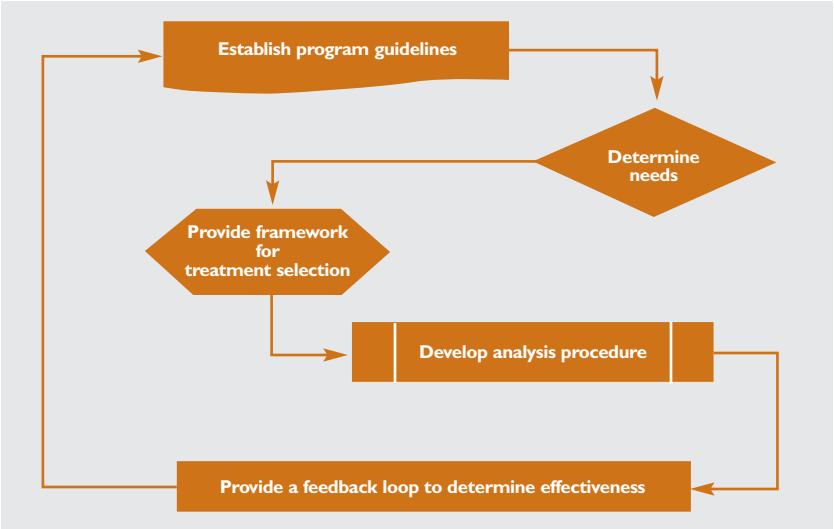

FIGURE 3 Pavement preservation process.

Essentials for Success

Pavement preservation is not a maintenance program, but an agency program. Almost every part of an agency should be involved. Success depends on support and input from staff in planning, finance, design, construction, materials, and maintenance. Two other essentials for an effective program are long-term commitment from agency leadership and a dedicated annual budget.

Agency personnel must address many critical issues before implementing a pavement preservation program. For example, terminology must be defined clearly and concepts such as cost-effectiveness, optimal timing, and pavement performance should be understood. Integrating pavement management with pavement preservation, to maximize the benefits to the highway network, also is imperative. In addition, agency personnel should be instructed about each preservation treatment and its appropriate use.

After preparing the groundwork, the next step is to tailor a program that meets agency needs. People with a thorough understanding of pavement engineering should develop preservation guidelines that relate to various pavement conditions, the purpose and limitations of each treatment, and the expected performance. The guidelines will assist in treatment selection and program assessment.

A good preservation program should establish continual monitoring to assure effective feedback for improvement of the guidelines. A process model is shown in Figure 3.

Issues and Barriers

Several issues and barriers may arise as an agency develops and implements a pavement preservation program. The issues and barriers, however, vary for each group involved.

Institutional Changes

Some of the issues and barriers from the transportation agency point of view may include the following:

◆ *Identifying a champion for the program.* Like any new effort or program within an agency, pavement preservation needs a champion. Without a champion to promote the importance and benefits, the new effort will not succeed.

◆ *Dealing with the paradigm shift from worst-first to best-first.* One of the biggest obstacles is convincing agency personnel to move from the tried-and-true practice of fixing the worst pavement problems first to fixing good pavements while the bad ones continue to deteriorate.

◆ *Gaining commitment from the top management.* The program's success requires top management commitment. This includes a commitment for dedicated funding and for the resources needed to collect information on the effectiveness of preventive maintenance treatments. Pavement preservation projects will not warrant ribbon-cutting ceremonies—unless the top management recognizes the program's importance.

◆ *Showing early benefits.* Pavement management systems that can show the early effects of the preventive maintenance treatments on extending life or on reducing life-cycle costs are essential.

◆ *Selecting the right treatment for the right pavement at the right time.* Failure can result if the correct treatment is not used. For a new program, a single failure can overshadow hundreds of successes. The right treatment must be applied to the pavement in a timely manner.

Marketplace Pressures

The issues and barriers for industry groups mostly involve reluctance to disturb the status quo and include the following:

◆ *Competition between the suppliers of maintenance and rehabilitation treatments.* With the shift from the traditional rehabilitation programs of pavement overlays applied every 10 to 20 years to pavement preservation programs using new or different treatments, resistance can be expected from the suppliers of traditional rehabilitation materials. For example, hot-mix suppliers will resist new cold-mix treatments because of the likely loss in market share.

◆ *Competition between various suppliers of maintenance treatments.* When markets have been established for certain types of treatments and a new treatment type is being introduced, industry often works to block the new products, whether for technical reasons or for business reasons, again to avoid loss of market share.

◆ *Political lobbying to prevent use of new maintenance treatments.* In some cases, industry will rely on political lobbying to prevent new technologies from entering the market. Again the reasons may be technical but more than likely are related to the effect on the market if an agency adopts the new technology.

◆ *Establishing the benefits of new technologies or treatments.* Suppliers often introduce new technologies without adequate evidence of the benefits. The supplier must provide the agency with detailed documentation of the product's benefits and performance.

Convincing the Public

The introduction of preservation programs also affects the traveling public—the ultimate customer—raising a different set of issues and barriers:

◆ *Understanding the shift from repairing the worst pavements first to the best pavements first.* The public does not understand why agencies would be working on good roads but letting the bad roads deteriorate. Most of the public understands the importance of maintaining a car or a house to prevent major repairs. Pavement preservation engineers should be able to explain the value of preventive maintenance treatments now compared with the cost of major repairs later.

◆ *Understanding the effects of the various maintenance and rehabilitation strategies on delays and vehicle costs.* Primary benefits of pavement preservation include the potential for reducing traffic delays by using faster repair techniques and for reducing user costs by maintaining pavement networks in better condition. Although widely acclaimed, these benefits still lack the documentation of national studies.

◆ *Understanding safety issues.* Increased safety for the traveling public and for workers in the work zone are other potential benefits from keeping roads in good condition through pavement preservation treatments; these benefits also need to be documented and communicated.

"Preventive maintenance has gone high-tech and is now being used in conjunction with other applications to preserve pavements—it is moving beyond the low-volume road sector to extend the service lives of our most heavily traveled Interstate highways."
—Gayle King, Koch Pavement Solutions, Wichita, Kansas

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