A3C05: Committee on Pavement Maintenance
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State of the Art and State of the Practice in Pavement Maintenance

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The Committee on Pavement Maintenance is concerned with causes of deterioration of the surface and the subsurface of degraded or slippery pavements and shoulders as well as preventive and corrective measures involved in improving such conditions.

TREATMENT TYPES

Numerous pavement maintenance techniques and practices are used worldwide. The most commonly used techniques for flexible pavements are

- Crack sealing,
- Patching,
- Fog seals,
- Sandwich seals,
- Sand seals,
- Surface dressing (chip seals),
- Thin cold seals,
- Cape seals, and
- Thin and ultrathin hot-mix asphalt overlays.

For rigid pavements, the most commonly used techniques are

- Patching,
- Joint sealing,
- Joint and spall repairs,
- Load transfer retrofit, and
- White topping.

Agencies specify the treatment to be used on the basis of their knowledge of existing pavement distresses, anticipated traffic loading, environmental conditions, cost of the treatment, and performance history of the different treatments. Several kinds of seals for flexible pavements may be restricted to low-traffic-volume facilities because of an agency's prior experience with the performance of these types of seals on higher-trafficked pavements. Chip seals are generally used on pavements where the average daily traffic count is fewer than 5,000 vehicles, because cover aggregate loss can cause damage to

vehicles. Of course, there are exceptions to this, particularly owing to advances in the use of polymer-modified binders for this procedure.

Pavement condition data, collected by trained observers or by automated equipment, reflect many different pavement characteristics. Agencies acquire data with their own forces and either evaluate the data in pavement management systems or contract this task to consulting engineers. Some agencies have not developed the ability to share pavement management data among their divisions; as a result, decisions regarding specific treatments are made without the benefit of necessary information.

TREATMENT SELECTION

Many factors must be evaluated by a specifying agency when selecting a pavement maintenance treatment. These factors may include

- Cost of treatment,
- Type and extent of distress,
- Traffic type and volume,
- Climate,
- Existing pavement type,
- Expected life,
- Availability of qualified contractors,
- Availability of quality materials,
- Time of year,
- Pavement noise,
- Facility downtime (user delays),
- Surface friction,
- Anticipated level of service, and
- Other project-specific conditions.

An agency usually has an established procedure, or policy, for choosing appropriate treatments (*1*). The policy may include guidelines, goals, and strategies. Current practice is quite variable and ranges from choosing the treatment on the basis of past experience to using comprehensive computer programs that incorporate data analysis and modeling procedures. For example, if permanent deformation in a flexible pavement is determined to be the primary distress and it is confined to the surface layer, some treatments (e.g., microsurfacing or thin hot-mix asphalt overlays) would be better suited to match this distress than others (e.g., fog seal or surface dressing).

Cost-Effectiveness Evaluation

Many different procedures are used to evaluate the cost-effectiveness of potential treatments (*2*), and this step is fundamental to the treatment selection process. Some procedures are simple and straightforward; others require significant amounts of data. Determining which factors to include in the analysis and developing evaluation procedures are the responsibilities of the specifying agency.

Mix Design Procedures

Standardized design procedures are available for most treatments and are published by the American Association of State Highway and Transportation Officials (AASHTO), the

American Society for Testing and Materials (ASTM), and other international standards organizations. In addition, many agencies have developed their own design procedures that reflect local knowledge of materials and procedures. However, many people still consider some pavement maintenance systems to be more of an art than a science. For some treatments (e.g., fog seals and sand seals), the principal determinant in choosing the treatment is the condition of the existing pavement, which will, in turn, affect the application rate for the treatment. Thus, there is no "design procedure" per se. Progress is warranted in design procedures for several pavement maintenance systems.

MATERIALS SELECTION

Many maintenance treatments are thin (25 millimeters or less), and others must bond to the existing materials. To achieve anticipated performance, pavement maintenance engineers must select high-quality and compatible aggregates, binder, and other essential ingredients (cement, fly ash, etc.) for the treatments. Adequate friction resistance is desired for many of these treatments, and selecting aggregates with this characteristic is an important safety consideration. Reinforcing steel for load transfer retrofit usually must be coated, and polymers have been used to modify emulsions or asphalt cement for flexible pavement applications, improving cost-effectiveness and performance.

APPLICATION PROCEDURES

Although most of the construction procedures in pavement maintenance activities have remained essentially unchanged for many years, notable advances have been made in the use of automation to control several functions, such as finishing pavement, applying materials, measuring materials in mix plants, and operating patching machines. In fact, automation has become standard in many agencies.

As a result of studies conducted during the Strategic Highway Research Program (SHRP), significant improvements in crack-sealing techniques, pothole patching mixes and equipment, and Portland cement concrete pavement repairs have been widely implemented.

SPECIFICATIONS

Material and method specifications predominate in the pavement maintenance field. However, several agencies (in the United States and elsewhere) have developed performance-based specifications, and others are using end-result specifications with warranties. Much of the reason for this shift is due to the trend toward having more pavement maintenance work performed by private contractors and reducing maintenance staffs in state departments of transportation (DOTs). In addition, some agencies have privatized total maintenance of portions of their systems by contracting the firms for five years or more.

TREATMENT PERFORMANCE

The performance of maintenance treatments can be difficult to assess, because the same treatment used under different pavement conditions will wear differently. Many factors can affect the performance of maintenance treatments, and Geoffroy provides the performance expectations of various treatments as reported by several agencies (*2*,*3*). However, when the agencies try to use life-cycle cost analysis, the life extension provided by a treatment at a given time and under the same pavement condition is essential information.

CHALLENGES FOR THE FUTURE

As the pavement maintenance community moves into the new millennium, many significant issues must be addressed. Agencies worldwide are faced with the daunting task of maintaining pavement assets with reduced staff and shrinking budgets. At a Forum for the Future sponsored by several public- and private-sector groups in late 1998, practitioners set out to create a map for the future. This map would include strategies for pavement maintenance procedures that would result in greater safety, convenience, and customer satisfaction to the traveling public (*4*). They determined that the following issues must be addressed.

Understanding Pavement Preservation and Preventive Maintenance

Because of limited resources, the move toward preserving our pavements by providing "the right treatment, to the right road, at the right time" is a concept that must be adopted if agencies are going to save money while meeting customer expectations. Agencies must better define the benefits of preservation programs and preventive maintenance techniques, and this concept must be communicated to motorists.

Pavement preservation is an inclusive term that considers all the "activities undertaken to provide and maintain serviceable roadways" (*4*); it covers corrective and preventive maintenance as well as some rehabilitation. Preventive maintenance is defined by AASHTO's Subcommittee on Maintenance as "the planned strategy of cost-effective treatments to an existing roadway system and its appurtenances that preserves the system, retards future deterioration, and maintains or improves the functional condition of the system without substantially increasing structural capacity." Simply put, pavement preservation encompasses both protecting and preserving existing pavement assets by using many different strategies (which may include structural upgrading), whereas preventive maintenance is the process of maintaining roads that are already in good condition. Without a basic understanding of these approaches, few agencies will be able to garner support for pavement preservation and preventive maintenance programs from the traveling public, contractors, or legislators. Current trends in pavement preservation in many states indicate that pavement preservation concepts are being endorsed and implemented.

Integrating Pavement Performance Data

Data that reflect the effectiveness of pavement maintenance treatments are sorely lacking. Although data may be collected by many different methods within an agency, documentation is sparse, data may not be transferable, and data often are not analyzed in an organized fashion. This type of data is essential in making decisions concerning the most cost-effective treatment to apply.

The various management systems that currently exist (pavement management, maintenance management, project management, etc.) must be integrated to effectively manage pavement information and to improve pavement maintenance planning, programming, and scheduling. Some agencies are already integrating management systems, but more emphasis is needed. In fact, the lack of an integrated system impedes the implementation of effective pavement preservation programs. We urgently need to develop model programs in this area.

Dedicated Funding

Funds for pavement maintenance often are allocated from funds that are left over after all other programs are funded. In addition, in the event of a natural disaster, funds for the cleanup and restoration of services are taken directly from the pavement maintenance budget, thereby reducing the amount available for preventive maintenance activities.

To maintain a pavement system that meets customer demands and expectations, pavement preventive maintenance and preservation activities must have dedicated funding. Only with dedicated funding can planning, programming, and scheduling ensure the right treatment at the right time. Educating legislators and customers about the need for dedicated funding is an essential element of an effective pavement preservation program. Of all the program needs for pavement preservation, this is most essential. If funds are not available for a sustainable preventive maintenance program, the system is doomed to failure.

Performance Specifications, Quality Assurance, and Training

In light of the downsizing of agency staffs, an emphasis on performance-based specifications, quality assurance, and training issues is essential to improve strategies. New ideas specific to pavement maintenance activities must be considered to advance the technologies needed to meet customer demands. Although efforts to develop performance specifications have been made, a much broader range of materials and processes used in pavement maintenance activities should be included.

With few exceptions, only hot-mix asphalt specifications have improved during the past 20 or more years. Quality assurance for pavement maintenance activities is in the same predicament or at the same low level of progress and use as performance specifications. A few agencies have adopted quality assurance programs for maintenance, but much work remains to be done. As more agencies change from using staff maintenance forces to contract workers, better specifications and quality assurance become more important.

Training in all aspects of pavement maintenance is a continuum. Downsizing, new contract employees, and job changes affect the ability to maintain a well-trained workforce. Because of the shift toward contract maintenance, maintenance personnel who remain in the department must become contract managers. Very different skills are required for the new job description. In response to this need, the National Highway Institute is developing some programs; however, additional training programs are needed, and existing programs must be updated.

Research

Although materials and techniques for pavement maintenance have improved, more research is essential in the areas of policy development for the effective management of pavement maintenance, mixture designs, specification development, cost-effectiveness of treatments, and the best application timing of various treatments. Some of the important needs follow.

Mix Design

Research is needed to develop better, more comprehensive mix design procedures for pavement maintenance. The techniques should be related to predicted performance and useful in the quality assurance process. Procedures to evaluate various kinds of thin treatments must be developed by using sound engineering principles.

Timing of Pavement Maintenance Treatments

Although SHRP research in determining the best time to apply various maintenance treatments to obtain the greatest return on the funds expended has begun, much analysis of the existing data is needed, and conclusions must still be reached. Additional studies should be undertaken to determine the correct timing for the placing of pavement maintenance treatments in localized environmental conditions with locally available materials.

Materials Selection

Aggregate specifications for pavement maintenance treatments must be evaluated. Often, the specified materials follow standard construction specifications; however, when thinner treatments are used in maintenance applications, more durable aggregates may be required to obtain expected performance.

Many maintenance treatments contain emulsified asphalt cements, and the compatibility of the aggregate and the emulsion is critical to the success of some mixtures. When materials are used in patching, they must bond to the materials in the existing pavement layer and perform as a part of the existing material. They often must also be exposed to traffic shortly after installation. These kinds of specialized requirements need to be considered in the selection and specifications of maintenance materials.

Construction Practices

Maintenance activities are much more time-sensitive than construction activities. Therefore, equipment and methods must be developed that facilitate the timely application of maintenance treatments with the desired level of quality. Although SHRP studied some aspects of pavement maintenance techniques and equipment, much remains to be done. Simplified practices for maintenance activities, such as those developed by the Kansas DOT, need to be expanded.

Specifications

As noted earlier, some work has been done in this area, but novel approaches must be explored for maintenance activities. In most instances, simply adopting construction specifications for maintenance is not appropriate. Research is sorely needed in performance-based specifications and end-result specifications with warranties for maintenance activities.

Performance of Pavement Maintenance Techniques

The industry must begin to develop comprehensive techniques to document the performance characteristics of the various pavement maintenance procedures that can be used to predict performance. Although the performance of some maintenance treatments started to be documented in the SHRP studies, additional studies must be completed using other treatments, locally available materials, and performance-based mixture designs to provide the performance information needed to incorporate pavement maintenance treatments into pavement management systems. If an agency cannot explicitly demonstrate to its customers that the pavement preservation strategy is cost-effective and provides a safe, smooth roadway, it will not obtain the support to continue the program.

REFERENCES

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