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Pavement Management Systems
A National Perspective

FRANK V. BOTELHO
Federal Highway Administration
Washington, D.C.

INTRODUCTION

THE HIGHWAY NETWORK IN THE UNITED STATES REPRESENTS A MULTI-BILLION DOLLAR INVESTMENT which allows for the essential movement of people and goods. Preservation of pavements is vital to the operation of this network. Sound management and engineering are needed to maintain, rehabilitate, and reconstruct highway pavements. During the past 2 years, the Federal Highway Administration's (FHWA) Offices of Operations and Planning conducted 10 case studies of State highway agency (SHA) Pavement Management Systems (PMS). The information gathered from these studies was used as the backbone for a 1-day management level seminar on PMS. To date, the FHWA has conducted 26 seminars and 7 more are planned. This compendium presents the rationale behind PMS and its status in the United States based on the case studies and seminars mentioned above.

OBSERVATIONS

Today most SHA's have a PMS or have made the decision to develop and implement a PMS. States with an operational PMS agree that it provides valuable assistance to decisionmakers in determining cost-effective strategies for providing and maintaining pavements in serviceable condition.

In practice, a PMS is a systematic approach that provides quantifiable engineering information to help highway administrators and engineers manage highway pavements. The total decisionmaking process is based on information from a PMS coupled with engineering experience, budget constraints, scheduling parameters, management prerogatives, public input, and political considerations.

More specifically, SHA's use the PMS to estimate pavement needs at the network level by monitoring condition, usage, costs, and performance. In addition, the SHA's use the PMS pavement performance data as feedback to evaluate and calibrate pavement design procedures, evaluate the cost-effective performance of rehabilitation and maintenance techniques, and evaluate the relationship between pavement performance and materials and construction quality. This is a lesser-known, but equally important role of a PMS.

BASIC ELEMENTS

All SHA's address the same basic elements in their PMS.

1. A NETWORK INVENTORY - is used to establish the physical features and history of the pavements. It includes such features as center-line mileage, number of lanes, widths, shoulder types, and functional classification. States consider as-built cross section data highly desirable, but it is not always readily available for easy entry into a PMS data base. Some systems have expanded inventories that include materials information, construction quality, drainage, and pavement history.

2. QUANTIFIABLE ROADWAY DATA - is collected to monitor and assess the condition and serviceability of the network's pavements. Most State PMS's collect ride (roughness) and distress data. Some collect deflection data at the network level to provide a general assessment of the structural carrying capacity. By comparison, deflection data is more costly to collect and requires closing a lane; therefore, States approach collection of this type of data more prudently. All States collect skid data. The type, extent, and frequency of pavement data collection depend on the nature and size of the network, functional classification, climate, soils, traffic loadings, the rate of deterioration, and organizational needs. Each agency decides the type of equipment, crew size, and method of data collection based on currently owned and available equipment, cost, speed and ease of operation, engineering preference, and future needs. The trend in the United States is toward automated equipment operating at highway speeds.

3. LOAD DATA - is used to quantify present and future pavement performance and the rate of deterioration. Some States use backcasting and forecasting to gauge how much structural life of the pavement has been used and how much remains. Most highway engineers believe Automatic Vehicle Classification (AVC) and Weigh-In-Motion (WIM) equipment, when used in conjunction with a statistical based traffic program, will provide essential information on truck volumes and weights. The AVC and WIM equipment are considered a major asset to a PMS. Many States eagerly await the full development of piezoelectric cables for low-cost installations. States are putting more effort into forecasting future truck volumes and weights.

4. A DATA BASE - is used to compile the PMS data using a common referencing system or a cross-correlated referencing system. Presently milepost markers are the most common referencing point, but the trend is shifting toward Geographic Information Systems (GIS) that use coordinates. Data bases typically

encompass the network inventory, project history, condition survey, skid, deflection, load, performance, and construction cost data (average unit bid prices). Maintenance data is the latest addition to many PMS data bases. Because this data is often located in several departments of a highway agency and the integrity of the data is extremely important, highway agencies usually give one person in the central office the authority to maintain tight control on the functioning aspects of the PMS data base. Most States use commercially available software programs called "data base managers" to handle the PMS data. However, some personalized programming is usually required to achieve a totally integrated data base.

5. DATA ANALYSIS CAPABILITY - is used to support the objectives of a PMS. Most agencies compute a condition rating based on ride and distress data. The States commonly set priorities for network needs based on condition, load, skid resistance, and, in some cases, deflection. Quantitative pavement performance data is becoming a major input in estimating network level needs and setting priorities. Each highway agency formulates its own analytical methods, such as a condition index, priority matrix, decision tree, and higher order mathematical models based on the nature and performance characteristics of the network. State engineers formulate the engineering decision criteria and the weighing factors used in the analytical procedures based on the goals set by the SHA and the conditions existing in the State.

PROCESS

A typical PMS recommends a maintenance, rehabilitation, or reconstruction strategy for the candidate projects. The decisionmaking process is a concerted effort by the programming office, project selection committee, central office, and the district field offices. They go through an iterative process considering PMS information with all of the other factors. This comprehensive process establishes the State's annual construction work plan, which the Chief Engineer approves. After a work plan is approved, the projects are submitted to the pavement design engineer for completing a total engineering evaluation, selecting the proper design alternative, and preparing the final design.

PRODUCTS

1. Quantifiable engineering information is used in the decisionmaking process to develop annual work plans and multi-year work programs.

2. Documented pavement performance data based on in-service conditions is used to evaluate the accuracy of pavement design procedures, the cost-effectiveness of rehabilitation and maintenance techniques, the quality of construction and materials as it relates to pavement performance, and the anticipated network pavements needs.

3. Many reports and analyses are produced for legislatures, highway managers, and the public that address the present and future condition of the network, along with "what-if" economic scenarios.

COMMUNICATION

Communication is just as important as engineering and management. Practitioners realize the results of a PMS can be wasted unless they are properly communicated to all levels and departments of a highway agency, to elected officials, and to the public. Highway departments are rapidly making progress in this area by using the latest in computer graphics, management reports, and special audio/visual presentations.

IMPLEMENTATION

The PMS's have been successful because they have been supported by top management. In some cases, State legislatures have mandated establishment of a PMS. Development and implementation have been the direct result of hard work by highly skilled and dedicated people.

States definitely tend to use existing resources to the maximum extent possible. The average SHA has assigned one to two engineers full time to the PMS. Usually one to two technicians are assigned to the PMS on a full-time basis or as a shared responsibility. Data gathering crews are generally on-board personnel who previously had technical training and experience in testing and data collection.

Most PMS's have become operational through stage implementation, which yields such immediate results as a Condition Summary.

FUTURE ASSESSMENTS

In the next decade, look for six areas to change: (1) inventories will expand because of increased demand and usage, (2) data collection equipment will be more automated because of innovations by private industry and SHA's, (3) analysis capabilities will be enhanced because of continuous engineering feedback and increased experience, (4) load data will be improved because of WIM equipment, better classification equipment, and improved sampling procedures, (5) pavement performance data will greatly improve through in-service PMS monitoring, and (6) pavement design procedures for new and rehabilitated pavements will be improved because of the PMS engineering feedback system.

CALL FOR ACTION

Great strides have been made in the past 10 years, but the job is not finished. Here are some new activities that PMS practitioners can participate in and continue to make important contributions to the advancement of better PMS's.

1. AASHTO has a special Task Force overseeing the update and expansion of its guidelines on PMS.

2. Several State practitioners want to create a national organization so they will have a forum for meeting and sharing their experience.

3. A 2-week advanced course on PMS's for practitioners has been proposed by a joint State/Federal Task Force.

These are only a few examples of actions that are needed. The PMS's will continue to improve only if we continue to work as hard as in the past decade.