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STATUS REPORT ON PAVEMENT MANAGEMENT

by

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(The opinions, findings, and conclusions expressed in this report are those of the author and not necessarily those of the sponsoring agencies.)

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SUMMARY

The report traces the developments in pavement management in the Virginia Department of Highways and Transportation from the initial efforts in the mid-1970s through early 1984. Included are status reports on pavement management for the interstate, primary, and secondary systems with examples of the monitoring procedures used, the outputs available, and the uses of those outputs.

Recommendations address a needed transition in data processing to the on-line mode, the appointment of a Central Office pavement management coordinator, and the appointment of a pavement management specialist or technician in each district.

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INTRODUCTION

The foundation for effective pavement management was established by the American Association of State Highway Officials (AASHO) in the early 1960s with the publication of the results of the AASHO road tests. (1,2) Those studies showed that pavements perform in a predictable manner as described by the curve given in Figure 1. Typically, a pavement loses serviceability (deteriorates) very slowly for several years, then enters a period of rather rapid decline toward total failure. This period of rapid decline is marked by the presence of cracking and deformation and a decrease in rideability. As indicated in Figure 1, an overlay at some time after the period of rapid deterioration begins can restore the pavement to where a new cycle begins.

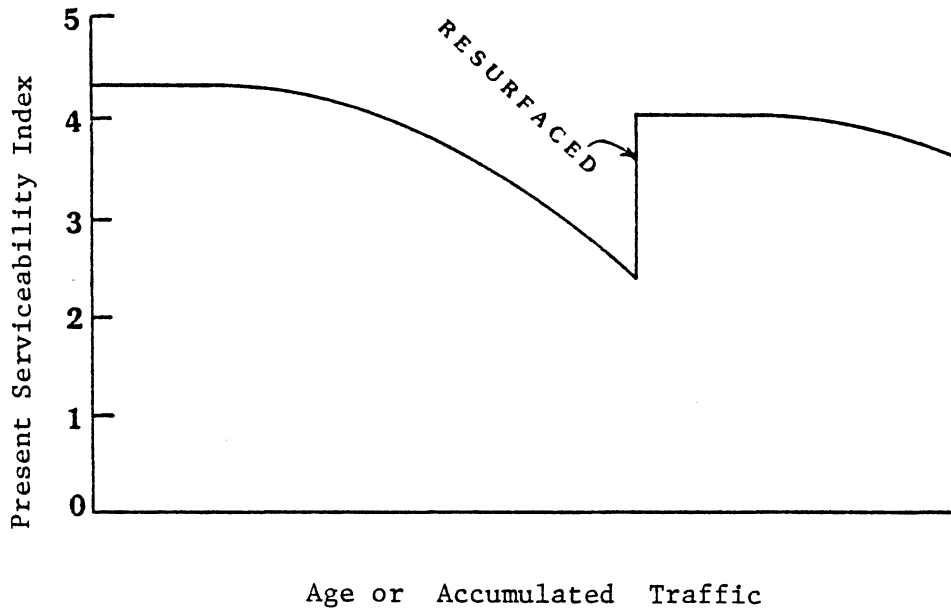


Figure 1. Typical pavement performance curve.

In projecting long-range pavement maintenance requirements the predictability of the relationship depicted in Figure 1 is useful. The road test data showed that the shape of the pavement deterioration curve is generally related to traffic through a distress function defined in terms of load and design variables. For a particular pavement, an approximation of that distress function can be developed from at least two measurements of pavement condition and the traffic and age parameters at the time of the condition measurements. The distress function may then be used to predict pavement conditions at a later date. Conversely, if one can define the condition level at which major maintenance will be required, the distress function can be used to predict the approximate time of that maintenance.

Formal pavement management efforts in the Virginia Department of Highways and Transportation began in the mid-1970s when maintenance and research personnel cooperated in developing a pavement condition rating system based on the quantification of factors field engineers use to make decisions as to when pavement maintenance replacement will be performed.⁽³⁾ The rating system was demonstrated and refined during 1979-80 and applied to the full interstate system in 1981.^(4,5)

Based on the condition rating system, the general broad approach to pavement management for the state was set forth in a 1981 report in which pavement management was defined as predicting future funding needs for pavements and providing top-level management with data to indicate what level of service can be maintained within each funding level.⁽⁶⁾

Potential benefits of pavement management given were --

1. improved performance monitoring and forecasting,
2. objective support for funding requests,
3. identifiable consequences of various funding levels,
4. improved administrative credibility,
5. a basis for cost allocation to highway users, and
6. improved engineering input for policy decisions.

Among pavement management elements discussed and deemed applicable to Virginia in the above mentioned report were --

1. pavement condition (distress) inventory,
2. pavement structural integrity,

3. pavement ride quality, and
4. pavement skid resistance.

Pavement management costs estimated in the 1981 report were developmental costs of \$125,000 to \$150,000 per year for each of the first two years and an annual operating cost of about \$90,000 thereafter.

Subsequent to the 1981 report, a pavement management steering committee appointed by Maintenance Engineer C. O. Leigh issued its report setting forth recommendations for the development and implementation of the first phase of formal pavement management. (7)

Those recommendations included the following:

1. Visual condition surveys should be conducted on the interstate system in odd numbered years and on the primary system in even numbered years. These surveys should be conducted on 100% of the systems.
2. Visual condition surveys should be conducted on 3% of the secondary mileage each year. This recommendation was later modified by the committee to 5% of the system in odd numbered years.
3. Skid tests should be conducted on the entire interstate and primary systems such that the entire systems would be tested each 4 years.
4. Roughness tests should be conducted on the interstate system concurrent with the visual surveys each even numbered year.
5. The Department, through the purchase and use of a digital profilometer or equivalent equipment, should equip itself to efficiently conduct roughness tests on the primary and secondary systems.
6. A deflection survey should be conducted on the entire interstate the first time it is visually rated, at the least. The frequency and need for subsequent tests would depend upon the results of the first survey.
7. Training sessions for the visual condition survey teams should be conducted prior to each of the first two years and thereafter as needed.

The development and implementation process has followed the above recommendations with minor modifications as discussed below. It should

be noted that the pavement management efforts to date have focused on flexible pavements only. A somewhat different approach, under development at the Research Council, is required for concrete pavements.(8)

PROGRESS

Interstate

Following a fall 1981 training session, all condition surveys, roughness tests, skid tests, and deflection measurements were completed on the interstate system by early 1982. All data were collected on the basis of physical mile markers rather than the traditional county mileposts. This approach, although helpful to personnel collecting the data, has hampered efficient merging of the interstate pavement management data with previously existing automated data files. For this reason, subsequent inventories on the interstate probably will be collected on the basis of county mileposts.

As discussed in detail in an earlier report(5), the interstate pavement management effort has resulted in a printout on which the following information is given for each mile of interstate flexible pavement.

1. location and direction of travel
2. surface mix type and date placed
3. condition rating (DMR)
4. roughness
5. cumulative 18,000 lb. axle loadings sustained by the surface course
6. year in which the next overlay is projected to be required
7. deflection characteristics
8. average skid number

Later printouts will provide estimates, based on deflection data and prevailing traffic, of required overlay thicknesses.

The interstate data, as presently given, are valuable tools for both field engineers and upper management. Field engineers use the data to prioritize surface maintenance replacement activities to ensure that

funding is directed to the most pressing needs, and they also find the data of value in responding to public inquiries and disagreements relating to resurfacing priorities. The data were used extensively by all levels of management in establishing maintenance replacement schedules for 1983 and 1984. An important use of the data in project development is in the justification of federal 4R funding.

Central Office personnel can use the data in projecting long-range maintenance replacement, in which consideration must be given to needs, legislative inquiries, and the documentation of funding requests.

As subsequent biennial inventories are conducted, the data will become even more useful and reliable and may provide valuable feedback to pavement design personnel.

Among the more important findings of a research analysis of the interstate pavement management data were the following:

1. The condition inventory method is capable of differentiating among candidate projects for the establishment of maintenance replacement priorities.
2. The ride quality of Virginia interstate pavements is generally so high that roughness tests are of little value in priority programming.
3. A significant portion of the interstate system is structurally inadequate for the prevailing traffic.
4. If the inordinate increases in 18,000 lb. equivalent axle loadings experienced over the past several years continue, dramatic decreases in the average life of overlays can be expected.
5. A 5% random sample of pavement sections is adequate for system monitoring purposes.
6. Condition rating teams for the various districts rate pavements on a reasonably consistent basis, although there will be a continuing need for surveillance and training of the teams to prohibit any biases which might otherwise develop. (3)

Primary

The first condition inventory of primary system pavements was completed in the winter of 1982-83. Unlike the first inventory of the interstate system, work sheets did not originate in the field but were

provided by the Information Systems Division from a previously developed data base called the "Surface Mix Section Direction Report." An important part of the inventory was the updating of the automated files to correct inconsistencies between observed conditions and those given on the computer printed work sheets. Data for the some 10,000 miles of flexible pavements on the system were collected on the basis of changes in the age or type of surface mixes. Divided highways were inventoried in both directions. Some 16,000 work sheets were submitted to the Maintenance Division for review and the initiation of changes in the data base.

In October 1983, the Information Systems Division provided the first comprehensive computer printout of primary system pavement management data.

First, condition rating (DMR) values are given for each county, residency, district, and the state as a whole. These values show that approximately 16% of the total primary system is below an arbitrary 80 DMR, while about 25% is above a 95 DMR. Clearly, any significant change in the statewide values between the 1982 ratings and those scheduled for 1984 will indicate either a general increase or decline in pavement quality. An example of the usefulness of these data may be seen in Table 1, where the percentages of primary mileage rating below an 80 DMR in each district are given. Note that there are significant differences between districts in the fraction of total pavements rated below 80. Research validation of these results has revealed a small tendency in the Culpeper District to rate pavements lower than average. Otherwise, field ratings are consistent with those done by research. Further, district rankings based on the ratings are extremely consistent with rankings in 1948 by Stevens et al. (9), where pavement performance was shown to be highly correlated to soil area and to traffic volume. Thus, both the 1948 and 1982-83 works show that the worst pavement conditions occur in the poor soil areas (Culpeper District, for example) and in the heavy traffic corridors. The latter is shown dramatically in the poor average ratings of pavements in the coal counties of western Virginia.

When verification is completed, it is evident that data such as given in Table 1, when weighted with traffic and other factors, will provide invaluable background for the allocation of maintenance replacement funds.

The second portion of the primary printout gives detailed DMR values and subjective ride ratings for each section of roadway. These values provide field engineers with a ready pavement condition reference for use in establishing maintenance and maintenance replacement priorities.

Table 1

Percentage Primary Pavements
 Rating Below DMR = 80
 by District (1982-83)

<u>District</u>	<u>Percentage Below DMR = 80</u>
Bristol	21.9
Salem	8.8
Lynchburg	13.1
Richmond	6.8
Suffolk	10.8
Fredericksburg	14.7
Culpeper	42.4
Staunton	5.4

Secondary

The first condition ratings on the secondary system were undertaken in the fall of 1983 and are scheduled for completion in 1984. Because of the enormous 44,000-mile system, the pavement management steering committee deemed full assessment to be unfeasible. Two decisions by that committee reduced field work to a manageable level. First, it was decided that the condition rating methodology was appropriate for only paved roads (some 31,500 miles of secondary roads). Second, it was concluded that a random sampling process could be used to monitor 5% of the system (about 1,500 miles) on a biennial basis. To expedite the sampling, an algorithm developed by information systems personnel was used to randomly select roadway sections from the automated file "Road Inventory Mileage Records."⁽¹⁰⁾ The system is devised to identify a totally new sample on each iteration (every second year). Once the roadway sections were identified, computer printed work sheets were provided to field personnel.

In the random sampling process employed it is implicit that the secondary pavement condition data be used somewhat differently from those for the interstate and primary systems. Specifically, the secondary data will be used to gain a biennial assessment of pavement conditions on a system or network basis. For this reason, the data will be most useful over a period that includes several assessments to determine whether or not maintenance levels are adequate. However, since the random sample is stratified over each county and over six levels of traffic volume, data could be immediately useful in the allocation of maintenance replacement funds over political subdivisions and traffic classifications.

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A major difference in the secondary data is their inapplicability to specific or project purposes. Since field engineers will have data on only about 5% of the secondary pavements under their jurisdictions, it will not be possible to establish priorities for action based on those data. However, since field personnel are so familiar with secondary pavements for which they are responsible, objective means of establishing priorities are not considered essential.

PROBLEMS ENCOUNTERED

Several problems with the development and implementation of an effective pavement management system have been identified. These are discussed briefly below.

Management Perception

A major issue in the development of a pavement management system has been top management's perception that such a system would shift the responsibility for many pavement maintenance and rehabilitation decisions from the field engineers to the computer. To the contrary, as has been noted in earlier reports, pavement management provides field engineers with objective tools with which to make decisions previously based solely on engineering judgment. (5,6,7) It, at the same time, provides top management with tools to document funding requests and to equitably allocate funds.

Gradual acceptance of pavement management as a useful tool has led to greater emphasis on development and implementation efforts. For example, data processing efforts on pavement management were upgraded from priority No. 11 in 1982 to priority No. 2 by late 1983. Further, management has found the pavement data useful, on occasion, to defend decisions questioned by those outside the Department.

Integration of Data Banks

An obstacle to ready implementation has been the difficulty in integrating and updating various automated data files. Perhaps the most serious problem relates to inaccuracies in the surface mix section report resulting from a breakdown in the flow of data on pavement resurfacing from the field to the Information Systems Division. In many cases, the pavement surface type and age found in the field have not corresponded with those given in the automated files. To correct these deficiencies, the following measures have been taken.

1. Computer printed work sheets are provided for condition rating, with instructions to rating personnel to rectify inconsistencies between the printed record and field observations.
2. For contract maintenance replacement, information to update the automated files must accompany the final package documenting payment for work done.
3. The districts are encouraged to input changes in the automated files directly through the district computer terminals.

An additional problem in handling data has been identified in the lack of on-line computer capability. As a result of the "batch" processing used by the Department, access to the various automated files is cumbersome and time consuming. For the same reason, data entry and updating require a large manpower and paperwork effort and cannot be conducted efficiently. Full implementation of a useable pavement management system will be unlikely until an on-line capability is available that will allow field personnel responsible for data generation to enter and use those data on demand.

Organization

While the Department has made good progress in the development and implementation of formal pavement management, full utilization of the system will be impossible without the proper organizational structure and manpower commitment. Developments to date have been a cooperative effort of Maintenance, Materials, and Information Systems divisions, and field personnel across the state. Yet, no individual is responsible for pavement management and no one works full-time on pavement management. Thus, all individuals involved see the pavement management effort as secondary to their other responsibilities. A subcommittee of the Pavement Management Research Advisory Committee has been charged with responsibility for recommending an organizational structure for pavement management. Although any major organizational changes should await the subcommittee's recommendation, it is clear to the writer that, at a very minimum, the Department should appoint a full-time pavement management coordinator. The coordinator should have responsibility for continued implementation of the system and for the timely collection, processing, and use of the pavement management data. It is also evident that at least one person in each district should be designated as the pavement management specialist for the district, with responsibility for the conduct of field reviews, the submission of data, and the provision of assistance to field personnel in the use of the system output.

RECOMMENDATIONS

Pavement management experiences in Virginia to date point to the need for several significant changes. These are:

1. It is recommended that the Department of Highways and Transportation pursue early transition to on-line computer capability for pavement management purposes.
2. The early appointment of personnel with pavement management as their major responsibility is recommended. While a subcommittee of the Pavement Management Research Advisory Committee is studying long-range management organizational needs, minimum interim needs should be addressed through the appointment of --
 - a. a Central Office pavement management coordinator with primary responsibility for the coordination of pavement management efforts among the various divisions and for the implementation of pavement management throughout the Department; and
 - b. one pavement management specialist in each district with responsibility for data collection and reporting and for providing assistance to field engineers in the use of pavement management outputs.

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