Pavement Evaluation and Pavement Maintenance

ELDON J. YODER
Research Engineer
Joint Highway Research Project
School of Civil Engineering, Purdue University

INTRODUCTION

The Indiana Department of Highways has embarked upon establishing a Pavement Management System (PMS). As a part of this, the Joint Highway Research Project has had an on-going research project for the past several years dealing with methods of measuring pavement condition in Indiana.

Research at Purdue on the use of roughness measuring devices dates back to the mid-1950's when the first Roughometer was constructed for JHRP. This instrument was used for many years for research by the Indiana Highway Bureau of Materials and Tests. Research was carried out at Purdue in the 1960's under contract with the Highway Research Board on comparison of methods of measuring pavement roughness. The First International Conference on use of Roadmeters was held at Purdue University on April 18-20, 1972. Papers from this conference were published by the Highway Research Board in Special Report 133 entitled "Pavement Evaluation Using Roadmeters."

Shortly after this Roadmeter Conference, the Indiana State Highway Commission purchased a Roadmeter. This instrument is stationed at the Research and Training Center and was used for research purposes until about mid-1975 when it was put to use evaluating pavements on a statewide basis.

In 1972 the Joint Highway Research Project started an extensive research project for the state highway commission on performance of continuously reinforced concrete pavements. As a part of this research, deflection measurements were made in order to evaluate critical deflections of this type of pavement. A Dynaflect was obtained which was also stationed at the Research and Training Center.

The two instruments mentioned above, the Roadmeter and the Dynaflect, have wide use for measuring pavement condition and evaluation of pavements. As a part of the activities of the Joint Highway Research Project, research has been carried out for the past several years on these instruments, and methods have been established for their use as routine evaluation tools.
PAVEMENT MANAGEMENT SYSTEMS

In a pavement management system consideration is given to all of the factors that might influence decisions relating to design and maintenance with the end-point of optimizing these decisions, generally in light of economic constraints. In the decision-making process, the engineer has a variety of alternates that he might consider for a given situation. Time of maintenance is generally a major factor to consider inasmuch as, in some cases preventive maintenance is the most economical approach, whereas in others deferred maintenance is the most economical.

When considering a network of pavements, for example a statewide system, the policy-maker must decide on the priority of maintenance. This includes considering various alternatives of maintenance (thickness of overlay or just routine patching for example) to make most efficient use of the money available.

TYPES OF SURVEYS

All pavement management systems must be based upon surveys of existing pavements. Three types of surveys are common: reconnaissance surveys, condition surveys, and evaluation surveys.

Reconnaissance Surveys

Reconnaissance surveys are carried out on a routine basis by most engineers. They are primarily visual inspection and qualitative judgments can be made about condition; quantitative values rarely come from the survey.

Condition Surveys

Condition surveys are made to determine condition of a pavement at a given time. Detailed data on causes for distress are not determined. This survey is aimed primarily at network analysis and yields information the engineer can use in setting priorities of maintenance over a period of years. Budgetary requirements can be determined from the condition surveys although some reliance must be placed on structural evaluation of the pavement for this.

Evaluation Surveys

Evaluation surveys are made on specific pavements to determine the structural capacity of the pavement. During this survey particular attention is paid to reasons for pavement distress.

Although the evaluation survey is aimed specifically at the project level, it will also help the engineer make decisions for the network analysis since the thickness of overlay and other items affecting costs can be evaluated in this analysis.
Figure 1. Sequence of Pavement Evaluation

I
RECONNAISSANCE
SURVEYS

FIELD SURVEY
BY ENGINEER

TENTATIVE
CONCLUSIONS

II
CONDITION
SURVEYS

INVENTORY
PAVEMENTS

STRATIFY
DATA
1. Pavement Types
2. Traffic
3. Geology
4. Environment
5. Etc.

STATISTICAL
SAMPLE OR
COMPLETE SURVEY

SURVEY
1. Visual
2. Roughness
3. Rutting
4. Faulting
5. Etc.

III
CONDITION
ANALYSIS

DETERMINE PCI
and/or PSI

DETERMINE
SIGNIFICANT
FACTORS
SEQUENCE OF SURVEYS

For optimum use the surveys should be carried out sequentially. Figure 1 shows the process for pavement evaluation. The three basic surveys are indicated on top of the figure and the various steps within the survey process are indicated.

The sequential process can be stopped at any time. Many times the reconnaissance survey itself is sufficient for making the necessary decisions. In others it might be necessary to proceed through the condition survey or through the evaluation steps. For completeness, it would be necessary to follow the steps sequentially from step I through step VI sequentially.

The reconnaissance survey is self-explanatory. The condition survey consists of three principal steps. First it is necessary to stratify the data on the basis of the conditions at the site. Second, the data are statistically sampled although in some cases the entire road may be surveyed. The third step is the survey itself.

The condition analysis may be the stopping point for many surveys depending upon the severity of distress and the needs of the governmental agency. The primary factors that can be determined from the condition analysis is how much of the road needs to be fixed, where the major distress is located, and at least to some extent, what priorities of maintenance can be set. A major objective of the condition surveys is to “flag down” pavements that need further analysis and detailed evaluation.

The third survey, evaluation, is a detailed survey made on selected pavements designated by the condition survey. The evaluation is based upon structural analysis of the pavements to determine type of maintenance required.

It is possible to complete the survey process during any one of the phases listed on the flow diagram of Figure 1. The detail required for a given step depends on the results of the preceding step, and the decision whether or not to proceed through the complete process depends upon the needs at that time.

METHODS OF MAKING CONDITION SURVEYS

Much has been written in past years on methods of making condition surveys. By and large these rely on roughness measurements using roadmeters, profilometers, or other instruments that measure longitudinal distortion of the pavement surface. Roughness data are correlated with the Present Serviceability Rating which is determined by a panel of individuals. Indiana uses the Roadmeter for condition surveys. Figure 2 shows typical correlations of pavement rating with Roadmeter output as determined for the state of Indiana.
USE OF CONDITION SURVEYS

A pavement management system permits the engineer to select alternates from an array of values to arrive at the best alternate to be followed. Generally, the optimization is based on economics although it can also be based on sociological or environmental factors. Doubtless, more consideration should be given to total energy consumed in the rehabilitation process. This includes energy of producing the material itself as well as energy consumed during construction. The backbone of the PMS is a computerized storage and retrieval system wherein a large amount of data can be analyzed in a relatively short period of time.

State-Wide Inventory Using Condition Surveys

The Indiana Department of Highways has started accumulating data on condition of the major highways within the state. The condition data is in the form of Roadmeter readings taken annually on a statewide basis. This condition data is stored in the computer at Purdue University and is cataloged on the basis of road contracts and type of pavement. Physical measurements of skid resistance and roughness are stored along with other pertinent information.

Figure 3 shows a printout of information for the northbound lanes of I-65 from the Kentucky border to northern Indiana. This figure shows at a glance information useful to the engineer for determining priority of maintenance. The horizontal scale shows road meter roughness in counts per mile as well as the PSI for concrete, overlay, and
Figure 3. An Example of Using the Roadmeter to Screen Highway Sections Relative to Their Serviceability (NB Travel Lane of I-65).

<table>
<thead>
<tr>
<th>CONTRACT</th>
<th>FREQUENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>6</td>
</tr>
<tr>
<td>I</td>
<td>9</td>
</tr>
<tr>
<td>I</td>
<td>4</td>
</tr>
<tr>
<td>I</td>
<td>3</td>
</tr>
<tr>
<td>I</td>
<td>7</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ROADMETER ROUGHNESS</th>
<th>COUNTS PER MILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.44</td>
<td>4.30</td>
</tr>
<tr>
<td>4.15</td>
<td>3.94</td>
</tr>
<tr>
<td>3.65</td>
<td>3.76</td>
</tr>
</tbody>
</table>

PSI-CONCRETE  = CONTINUOUSLY REINFORCED CONCRETE PAVEMENT  
PSI-OVERLAY  = OVERLAY PAVEMENT  
PSI-ASPHALT  = JOINTED REINFORCED CONCRETE PAVEMENT
asphalt pavements. The frequency of occurrence of roughness is given on the vertical scale. The matrix within the figure shows the contracts and type of pavement. The contracts for this were numbered from 1 to 56 starting at the southern border.

From Figure 3 the roughest pavements are Projects 27 and 46. These are jointed reinforced concrete pavements in the northern part of the state. In general, the overlay and continuously reinforced pavements have shown good roughness values and high PSI values. The majority of the contracts have PSI values greater than 3, suggesting that little work needs to be done on the entire road. Some of the rougher sections need resurfacing.

SUMMARY

Primarily this paper has emphasized the stages of evaluation of a pavement, and it has pointed out that a sequential process follows a logical procedure from condition surveying through evaluation surveys. The objective of the surveys is to permit the engineer to make decisions about types of maintenance that should be applied. This must be based upon fundamental knowledge of the behavior of the pavement and a detailed cost analysis of various alternatives. The primary point of the paper is that maintenance should be carefully analyzed and that there is no standard way to maintain a pavement and that each road has its own unique solution. Only after the engineer evaluates all of the alternatives can he decide upon the best alternative to use for a given situation.