Use of Condition Surveys in Pavement Distress and Performance Relationship

B. Frank McCullough and Phil Smith, Center for Highway Research, University of Texas at Austin

Many people in the field of pavement design have stated that one of the largest deficiencies in a pavement design system is the absence of a good relationship of pavement distress to pavement performance. With this in mind, we decided to explore the meaning of this relationship, examine any past work that had been done in this area, and begin some initial research directed toward establishing a relationship between pavement distress and performance. Four areas were studied: relationship of pavement distress to performance, pavement condition surveys, pavement profiles, and pavement maintenance.

RELATIONSHIP OF PAVEMENT DISTRESS TO PERFORMANCE

Relating distress to performance must be understood before any useful research can be conducted. The data shown in Figure 1 represent an attempt to explain this. Pavement design currently progresses from the inputs (block 1) to performance in the form of accumulated serviceability (block 4) by use of design models (block 5) and the PSI equations (block 6). Doing this overlooks pavement behavior (block 2) and pavement distress (block 3). Accumulated knowledge in these two areas in pavement design should be included in progressing from inputs to performance, but a step in the process is missing. This step involves the progression from distress to performance. Various mechanistic models exist (block 7) that can determine to a fairly accurate degree the pavement behavior given certain inputs; models also exist (block 8) that can determine to a less accurate degree pavement distress given certain pavement behavior. However, no models and very limited knowledge exist that allow the progression from pavement distress (block 3) to pavement performance (block 4). Thus information that will allow this progression, perhaps in the form of a distress weighting function (block 9) used in prediction models, is what is meant by relating distress to performance. By use of a well-designed research plan and by use of continued evaluation of the PSI equation and its terms (block 10), perhaps one can obtain enough information to determine these distress weighting functions and prediction models.

We felt that research conducted toward relating distress to performance should first consist of the determination of the various distress manifestations (cracking, spalling, faulting, scaling, and the like); their magnitudes; and their effect on serviceability and methods of correcting them. This can be done primarily by condition surveys, profile studies, and maintenance studies.

The various distress manifestations, then, need to be associated with distress mechanism. Doing this is more difficult than doing the first step of the research plan but can be done within a detailed work plan. These distress mechanisms, when determined, can be ranked according to priority. Then improvements in the model can be made or new models can be developed for predicting the ultimate goal—the performance of pavements.

PAVEMENT CONDITION SURVEYS

Before a relationship can be established between pavement distress and pavement performance, one must determine the types of distress that actually occur on pavements with information sufficiently detailed to differentiate the various types of distress. Thus we decided to conduct a detailed inspection condition survey to provide information on distress for further use in establishing the distress-performance relationship. The condition surveys included eight different highways and seven counties within Texas Department of Highways and Public Transportation District 14.

The most frequently encountered distress manifestation was patching. Fatigue cracking, mostly in the form of longitudinal and block cracking, was encountered fairly often. The rutting that occurred generally was fairly minor except on some of the secondary road sections. Edge deterioration was somewhat common in pavements with no paved shoulder. Bleeding was encountered often but usually was not severe enough to cause any problems. Raveling was fairly common but

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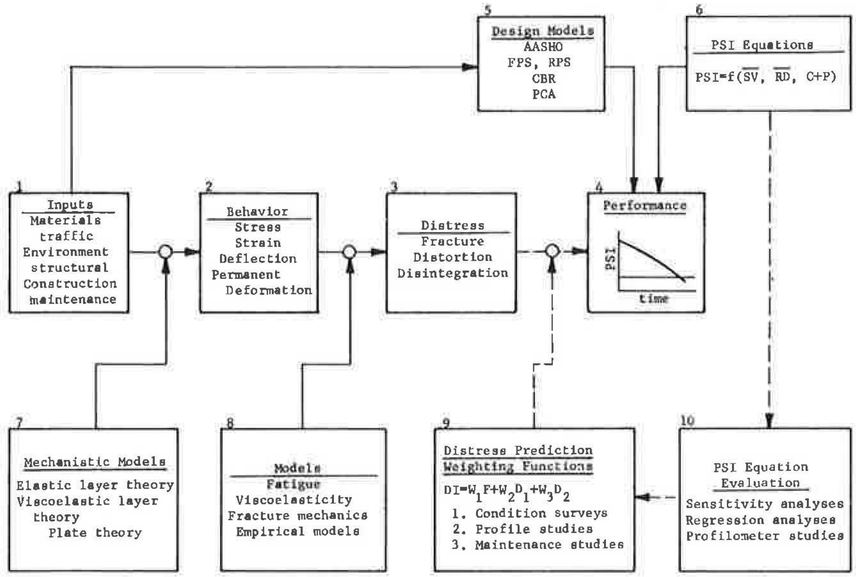
Figure 1. Distress-performance relationship with use of models.



usually not in a severe stage.

In classifying the distress according to the modes (fracture, distortion, and disintegration), we found that the great majority of distress manifestations were fractures. The only distortion to speak of was rutting. No noticeable transverse distortion was present. There was little, if any, swelling or settlement that could be detected visually. The major forms of disintegration were raveling and breakage of the pavement edge.

A meaningful step toward accomplishment of the objectives is the ranking of the distress manifestations according to their contribution of the total distressed area.

Manifestation	Contribution (%)
Patching	59.9
Bleeding	9.4
Rutting	6.1
Longitudinal fatigue cracking	6.0
Edge deterioration	4.9
Raveling	4.8
Block fatigue cracking	4.0
Alligator fatigue cracking	2.6
Edge cracking	0.9
Construction cracking	0.8
Longitudinal cracking	0.7
Shrinkage cracking	0.5
Transverse cracking	0.4
Total	100.0

PAVEMENT PROFILES

After discussions on the uses and capabilities of the surface dynamics profilometer, we decided that there was a good chance that it could be used to collect information about relating pavement distress to pavement performance. Because detailed information on types and locations of distresses was obtained in the condition surveys, profilometer data were collected on some of these sections and the results were compared to the condition survey.

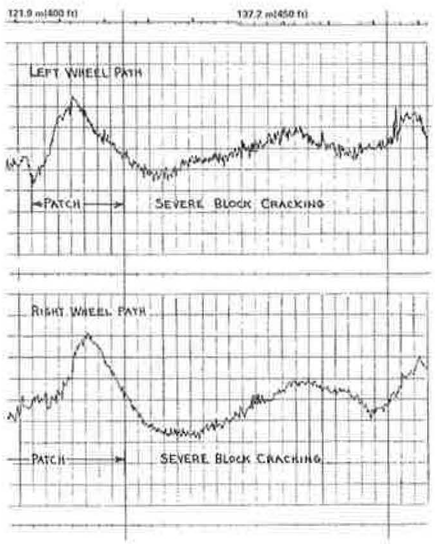
Four 0.32-km (0.2-mile) sections were chosen for profile study. The profilometer was run on these sections at a speed of 32 km/h (20 mph). The strip charts with the profiles of both wheel paths were then analyzed for any profile amplitude or wavelength patterns that occurred. The distress manifestations from the condition survey data sheets were indicated on the profile strip charts by scaling off horizontal distance from the beginning mark of the section. By doing this, we could study the profile pattern for an exact location or a specific distress manifestation. Portions of the strip charts on which this was done are shown in Figure 2.

The profilometer was used to collect serviceability index values for the pavement sections on which condition surveys were performed. It is interesting to note the serviceability index values that were obtained for the sections. The values range from 2.0 to 4.0, and the mean is 2.9. That the mean is as high as 2.9 is somewhat surprising. These values are terminal serviceability values because all of these sections were scheduled for rehabilitation. A mean value of 2.9 for a terminal serviceability is higher than the design terminal serviceability now being used by the Texas Department of Highways and Public Transportation. This indicates that the maintenance personnel who chose these highways for rehabilitation might tend to feel that a highway needs rehabilitation before it reaches design terminal serviceability. Further study in this area might provide useful information on the best design terminal serviceability values to use.

PAVEMENT MAINTENANCE

A study of the maintenance of pavements should be included in research directed toward relating pavement distress to pavement performance. A questionnaire on criteria used to select highways for maintenance was distributed in Texas Department of Highways and Public Transportation District 17 and asked for a rating of decision factors for various maintenance work. The maintenance forces weight the factors of pavement cracking, surface roughness, and type of existing base higher than the highway engineers do. Highway engineers stress raveling of aggregate, visible pavement deformation, skid values, and amount of traffic when considering pavements for maintenance. From results of the questionnaire, we concluded that the selection of pavements for maintenance is still an art the practice of which improves with experience. Collection of information of this type in other districts would be very useful.

Figure 2. Block cracking and patching on section 13, FM 971.



CONCLUSIONS AND RECOMMENDATIONS

We recommend that detailed condition surveys such as the one performed in this research be performed in other districts; each survey may have different distress in both occurrence and prominence. More comparisons of design terminal serviceability with actual terminal serviceability of pavements would also provide interesting and useful information on the proper design value for terminal serviceability. We recommend that a study be made of the history of pavements, including history of design, materials, dimensions, and types of surfaces, for comparison with the distress present on these pavements as an aid for relating distress manifestations and distress mechanisms. These would provide information that would help in determining the cause of certain types of distress.

Each area of study (pavement condition surveys, profile studies, and maintenance studies) can become the basis for a large-scale research project. We believe that detailed information collected in those areas can be combined into a distress-performance relationship that will enable the ultimate goal—the prediction of the performance of pavements—to be reached.