GROUP I

RELATING DISTRESS TO PAVEMENT PERFORMANCE

Chairman, W. Ronald Hudson; recorder, S. R. Yoder; members, John E. Burke, Fred N. Finn, Wallace J. Liddle, James W. Lyon, Jr., Lionel T. Murray, William H. Perloff, Robert L. Schiffman, Eldon J. Yoder, and Karl S. Pister

Initial discussions centered around a description of the performance function. Performance was generally recognized as the "system output function" or the variable to be optimized in a pavement system analysis. It was generally conceded that performance is defined by some record of the accumulated service of the pavement, i.e., a measure of how well it has served traffic.

MAINTENANCE CONSIDERATIONS

There was some discussion as to when and how pavement failure could be defined. In this respect, the following two questions were asked:

1. When and why are pavements resurfaced?
2. When and why are pavements reconstructed?

These questions led to a general discussion that the group thought would add information to the problem concerning why pavements are maintained. Basically, the following reasons were cited as the ones of major interest:

1. Management decisions;
2. Economic decisions (i.e., funds are available);
3. Desire to prevent deterioration after the observation of primary distress;
4. Poor serviceability conditions that need repair or correction;
5. Safety considerations, such as skid resistance;
6. Stage construction; and
7. Political factors.

Of these reasons, items 1, 3, and 6 seem to be amenable to evaluation by performance determinations. Other reasons seem to be primarily based on management or political decisions beyond the control of the engineer. However, the fact cannot be ignored that a maintenance intervention into the pavement system, for whatever reason, must be considered in subsequent evaluations of that particular pavement.

SERVICEABILITY EVALUATION

Discussions of methods currently in use by various state highway departments were presented at the group meetings. Most of the methods involved a serviceability rating by the road user or an index based on correlation with this rating. The only other major evaluation technique discussed was a mechanistic evaluation. As used by many highway departments, it primarily employs deflection measurements to evaluate the need for preventive maintenance but, of course, not as a direct way of evaluating the mechanism of pavement failure.

By unanimous vote, the group went on record to state that a present serviceability rating or present serviceability index pavement evaluation system is the most satisfactory method currently available for evaluating pavement performance.

Relating Distress to Performance

In considering the factors that affect pavement performance as indicated by the PSI equations from the AASHO Road Test, the group agreed that the effect that has the strongest direct weighting function is roughness. However, it was pointed out that there is a strong correlation between cracking and roughness and that a regression analysis on the pavement serviceability-performance data using cracking and patching as a primary variable (excluding roughness) gives a very high correlation between present serviceability rating and cracking and patching, a correlation coefficient of about 0.8 versus 0.9 for the equation using roughness. This indicates that quite often roughness and cracking and patching occur together in the pavement. The group pointed out that this could be due to one of the following two causes:

1. A pavement cracking up, causing water to enter and, thus, becoming rough;
2. A pavement becoming so rough with heaving or consolidation that it causes the surface to rupture or causes additional dynamic loads, which cause the pavement to crack more rapidly.

The group, in general, thought that this matter needed extensive study.

In summary, it was felt that there was no other way to relate distress to performance, except through some statistical analysis of serviceability-performance and distress information. It was also agreed, however, that any correlation similar to PSI should be carefully formulated and analyzed to determine causation, if possible, and not just correlation. This can perhaps be done by covariance analyses of the various factors involved.

It was pointed out by several group members that limiting deflections or limiting strains, when they are used as design criteria, are basically pseudonyms or stand-ins for a true measure of performance and not failure functions themselves. These can be obtained by observing deflection and subsequent performance as was done on the AASHO Road Test, or they can be evolved by more general experience but perhaps with less accuracy, as with the CBR method.

Quantitative Prediction of Distress

There was a discussion of the ability to quantitatively predict distress. One member pointed out that a true mechanics solution could only predict whether fracture would occur and not the quantity of distress.

What Distress Factors Need To Be Considered?

The distress interface with performance involves deformation almost totally, but some of the deformation is primary; i.e., it results directly from the accumulation of behavioral effects and thus directly affects performance. Other deformation is secondary, such as the deformation that results from water seeping into cracks where cracks are the primary distress factors.

DATA FEEDBACK SYSTEM

The group agreed unanimously that adequate records of feedback information must be kept and added to for evaluation of the design system. The data base or the data system has to be relevant to the problem and contain necessary information; however, data pollution, i.e., the development of unneeded data, is quite often a primary problem in such situations.

The discussions emphasized the importance of cognitive processes in this whole area of work. In general, the computer is a vital tool for handling the large data base involved. Additional study is needed on this subject by highway engineers.

DISTRESS FACTORS

There was a general discussion of how much information about distress factors could be obtained. The group realized that qualitative roughness information can be obtained

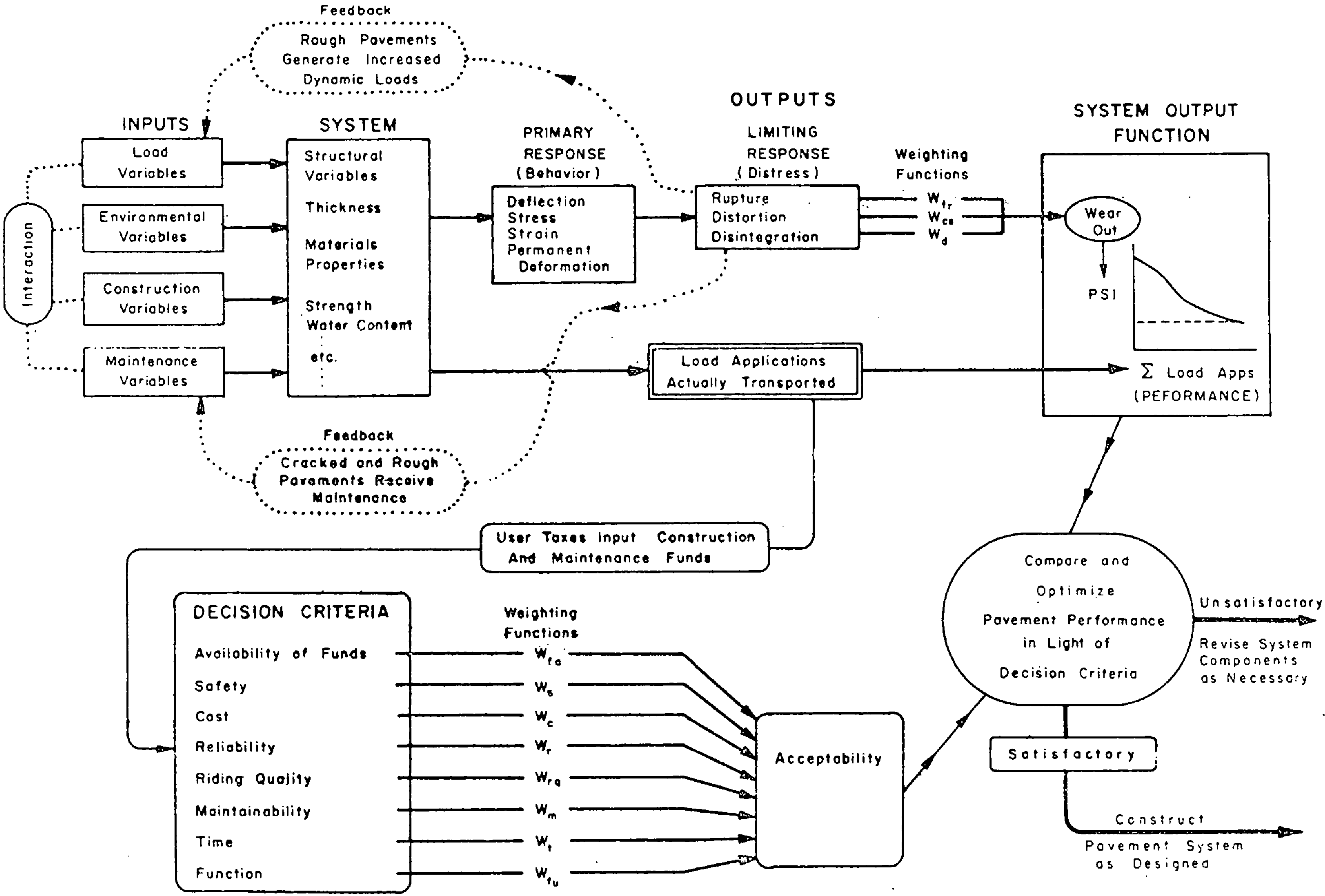

Figure 1. Pavement management system (from Finn et al.).

but that a considerable amount of research is needed to evaluate the effect of wavelength and amplitude of roughness on the vehicle and the driver. In all cases the evaluation of serviceability and performance should consider the driver and the vehicle as part of the roughness system. Additional information is needed on limiting factors that might be involved in performance. An example of this might be rutting where a specific rutting limit might be established as "failure" for reasons of safety. Thus, a pavement with a ½-in. rut might be declared failed. It was emphasized, however, that this condition might be corrected easily with an overlay and that an unsatisfactory or failed condition has nothing to do with the subsequent mechanistic evaluation that would be required to determine how the pavement might function after the overlay. It is this concept and the recycling effect that are necessary to any comprehensive design method.

In further discussions it was pointed out that we must be able to show benefits in order to sell the method and that we in fact need a realistic cost estimate of current methods and future methods to make a realistic benefit-cost analysis of changing the process.

RESEARCH NEEDS AND PRIORITIES

The group identified eight items of research needed to improve the performance function used in pavement design. These items are listed in order of priority in the following.

1. Specify a better relationship among service, performance, time, and traffic. It may be necessary in this context to bring in things such as utility theory (1, 2). The need is for a more definitive relationship that better delineates the factors involved, the weighting functions, and their relationship to the overall process.
2. Develop a more rational relationship between distress variables and serviceability-performance. This may of necessity include stochastic concepts.
3. Initiate a study of maintenance and the effect of maintenance on serviceability-performance trends of the pavement. Although this is considered by some to be an extension of design concept, there may in fact be a stabilization of factors in an existing roadway. This possibility and the problem of field evaluation make the need for research evident.
4. Organize a study to quantify and specify a data system for information feedback, storage, and retrieval. For the entire pavement management process, questions to be answered include: What data are to be obtained? How many data are to be obtained? How are the data to be stored? How are the data to be retrieved? How are the data to be processed and analyzed? Other factors include sampling plans, time, and frames for sampling.
5. Develop and implement such an information feedback system for the pavement management system.
6. Develop a plan for obtaining quantitative distress information.
7. Develop a better relationship between behavior and limiting behavior or distress.
8. Develop cost information on existing design processes and estimates on proposed processes to provide a comparison.

In addition to the eight priority items within the scope of the group's subject, it was felt that there was one priority item of interest to all groups, and this is the development of a systematic program to organize the research and development process in order to develop a rational pavement design system methodology. Such a process must be a total pavement and pavement research management system similar to that shown in Figure 1.

REFERENCES

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2. Stevens, S. S. Measurements, Psychophysics, and Utility. Measurements: Definitions and Theories (Churchman and Ratoosh, eds.), John Wiley, New York, 1959.