COMMITTEE ON MECHANICS OF EARTH MASSES AND LAYERED SYSTEMS

Russell A. Westmann

The scope of the Committee on Mechanics of Earth Masses and Layered Systems includes research and investigative studies related to theory and mechanics of the behavior of earth masses and layered systems. This includes the applications of elasticity, viscoelasticity, plasticity, and consolidation, as well as certain aspects of computer science, to predict behavior of the earth masses and layered systems. In addition, the committee's scope includes those studies that test the validity and accuracy of existing theories and methodologies under field conditions. The following comments are intended for anyone with interests and activities aligned with the committee's scope.

The workshop has clearly stated the pavement design problem in the context of a systems framework. This in turn has forced the committee to closely examine its role in the design process and squarely face its specific responsibilities in the overall system.

This role is primarily as follows: If the analyst is given the inputs of load and environment (or their statistics) as well as the proposed geometry and material components and their mechanical characterization, then he is asked to make the best possible prediction of the indicators of distress. In particular, it is desired that he estimate the permanent deformation, the appearance of fatigue cracking, and the propagation of existing cracks. General information the designer typically wants includes the stress and strain states and the displacement fields throughout the layered system.

Any activity that helps this committee to fulfill this role and improve the predictive capability outlined is justified. Otherwise, the activity is questionable as far as furthering pavement design is concerned.

In my opinion, committee activities pertinent to the design process are as follows.

IMPROVEMENT ACCESSIBILITY

The committee must encourage the continued availability of usable, well-documented, and properly maintained computer programs representing the most up-to-date prediction algorithms. In particular, effort must be immediately made to make the linear elastic and viscoelastic layered system theory available to the highway engineer through appropriate computer programs.

Because the designer wishes to know the stress, strain, and displacement fields throughout the system, it is necessary to present all of this information in such a way that it can be rapidly evaluated. One way of achieving this is by computer graphical display. Of course, other forms of presentation such as tables, charts, and graphs should not be overlooked.

ASSESSMENT OF METHODS OF PREDICTION

The committee must encourage and help with the implementation of the correlation of the best prediction methods with controlled and well-instrumented field tests. At the present time this means that the accuracy of the linear elastic and viscoelastic layered system theories must be assessed. In making such an assessment, the committee must interact with highway engineers.

EXTENSION AND DEVELOPMENT OF PREDICTION METHODS

In the event a prediction method is not sufficiently accurate, it becomes necessary to make appropriate modifications. A short-term modification might consist of certain engineering or ad hoc adjustments so that the predictions better fit the field results. For example, the linear elastic theory might be altered in an approximate manner to permit the prediction of the permanent surface deformations.

A longer range approach is to develop a more sophisticated theory by accounting for the material properties in a more realistic and accurate manner. Because the key point here is the mechanical characterization, members of the committee must be prepared to advise the materials group with respect to appropriate stress-strain-temperature-time relations as well as to assist with the solution to any boundary value problems pertinent to the test configurations. In characterizing the material, attention must continually be focused on the distress mechanisms of permanent distortion and fracture arising from environment and wheel loads.

Once the material characterization is completed, the improved prediction method can be developed by solving the appropriate boundary value problem. This new theory must then be assessed as before, and, if successful, the results must be made accessible to the highway engineer.

SPECIFIC PROBLEMS

Specific problems that need immediate attention include the following:

1. Stochastic analyses,
2. Analysis of the reflection problem,
3. Shoulder analysis,
4. Interaction of distress mechanisms, and
5. Pavement response to environmental inputs.

Until the present time surprisingly little has been done to determine the statistical response of a layered system due to a statistical distribution of loadings or for a nondeterministic set of material properties. This aspect of the analysis must be considered if the prediction algorithm is to fit into the overall design system.

In the future it is expected that the reflection cracking of pavements will be an important problem. At the present time even the simplest models do not exist, and the basic reflection mechanism is not understood. Another problem deserving attention concerns the effect of the finite width of the pavement or the presence of the shoulder of the road.

The interaction of distress mechanisms is an important topic not previously considered. For example, what is the effect of an existing crack on further crack development? Or, if permanent deformation leads to an uneven surface, then is the effective wheel load increased and further pavement distress hastened?

Finally, the problem of determining the response of layered systems subjected to environmental inputs has received little attention. Questions of just how thermal and moisture changes affect the pavement remain to be completely answered.

These are some of the more important problems that deserve the committee's immediate attention. To obtain complete answers to these questions requires close teamwork among the highway engineer, designer, materials expert, and analyst. Only in this way can a design answer be obtained that is acceptable within the systems framework presented at this workshop.