Overview

Although nondestructive tests (NDT) have been used for a long time, the last two decades have witnessed an explosion in the development of various types of equipment, uses of the test, and applicabilities of test results for pavement structural evaluation and backcalculation of layer moduli. Examples of such applications include:

1. Measuring the pavement surface deflection under an applied dynamic load for backcalculation of layer moduli and determination of the structural capacity of the pavement section.
2. Evaluating the load transfer efficiency at joints in jointed concrete pavements.
3. Assessing the need for and designing the thickness of an overlay to increase the structural capacity of the pavement section and enhance its performance under traffic loading.
4. Determining the rate of deterioration of the pavement structure.
5. Analyzing the effects of heavier axle load and higher tire pressure on the remaining life of the pavement structure.
6. Assessing the rate of deterioration of the pavement section and hence determining the critical time for rehabilitation.
7. Determining the location and extent of voids in the pavement structure.

In addition, it has become essential from the engineer's point of view to know not only the structural properties of the various pavement layers (typically determined in the laboratory using static or cyclic load tests), but also to know the behavior of the pavement structure and the interaction of the various pavement layers under moving wheel loads. This need has led, for each NDT device, to the development of various testing techniques and data evaluation procedures such that communication between engineers for the purpose of comparing their results has become a major problem. Hence, the need for standardization of test procedures, test location relative to the various pavement lanes and pavement joints, data reduction and analysis for the purpose of backcalculating layer moduli and comparing the results obtained by using different NDT devices was realized.

The difficult task of standardizing NDT procedures and backcalculation of layer moduli was undertaken by ASTM Committee D18 as early as 1980. The Committee has directed its Subcommittee D18.10 to expand its function and to develop the needed standards. However, it was realized that to accomplish this difficult task in a timely fashion, members of ASTM Committee D4 should also be involved. Hence, Subcommittee D4.39 of ASTM Committee D4 was established, and the task of establishing the standards was divided between the two subcommittees.

Along with a better understanding of the current state of the art of NDT is the need to evaluate whether recent developments in backcalculation of layer moduli procedures should be incorporated in a standard guide. Although modern NDT devices allow testing to be customized to fit various pavement evaluation objectives (such as stress dependency, location of voids, load transfer efficiency at joints), most NDT testing is not standardized. A major

objective of ASTM is to eliminate possible pavement evaluation problems resulting from misleading interpretation of results obtained through the use of different testing procedures and different devices by developing standard test methods that can be widely used. To achieve this objective, it is important to keep ASTM standard test methods current and to develop new test methods when the need arises. Further, said standards must be developed based upon the experience gained by the various individuals and agencies (i.e., users, manufacturers, etc.).

With the preceding in mind, Subcommittees D18.10 and D4.39 suggested to the executive committees that ASTM sponsor the International Symposium on Nondestructive Testing of pavements and Backcalculation of Moduli. The symposium was held in Baltimore, Maryland in June 1986 in four sessions (two sessions per day) and two workshops (one workshop per day). Due to an overwhelming response from the national and international professions, each daily session was held in two formats: paper and poster presentations. Topics for the poster presentations were taken from those from the daily session. The format of both paper and poster presentations was as follows:

Session 1—Backcalculation of Layer Moduli—State of the Art

Chairman: Gilberg Y. Baladi, professor, Michigan State University, E. Lansing, Michigan.

Speaker: Robert L. Lytton, professor, Texas A&M University.

Session 2—Nondestructive Testing (7 papers)

Chairman: Gilbert Y. Baladi, professor, Michigan State University, E. Lansing, Michigan.

2.1 Deflection Testing (five papers)
2.2 Radar Testing (one paper)
2.3 Surface Wave Testing (one paper)

Session 3—Backcalculation of Layer Moduli from Deflection Data (18 papers)

Chairman: Gilbert Y. Baladi, professor, Michigan State University, E. Lansing, Michigan.

Session 4—Procedures for Analysis of Nondestructive Testing Data (17 papers)

Chairman: Albert J. Bush III, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

Workshop 1—Backcalculation of Layer Moduli

Chairman: Gilbert V. Baladi, professor, Michigan State University, E. Lansing, Michigan.

Workshop 2—NDT Equipment and Computer Program Demonstrations

Chairman: Albert J. Bush III, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi.

Papers in this STP are presented on topics of the four sessions and workshops. Papers include examples of backcalculation of layer moduli procedures, comparison between the different NDT devices, correlations between devices, as well as the most recent examples of the use of computers and special equipment to automate data collection and make an instantaneous backcalculation of layer moduli. In the area of sensitivity of the test results to the various variables such as layer thicknesses, temperature, moisture, season, and load frequency, there are papers relating the latest information developed by various agencies in the world. Under data interpretation and analysis procedures, there are papers detailing the influence of assumptions such as seed modulus that are imbedded in the procedures upon the final results. The applicability of surface wave technology, ground penetrating radar, and infrared thermography in the pavement evaluation process is also presented and discussed.

It is the hope of the organizers of this symposium that the papers presented in this STP will provide the reader with much of the latest information in the areas of pavement evaluation using nondestructive testing techniques. Virtually, most possible combinations of test conditions, available NDT devices, and methods are addressed in this STP. The information contained in this volume will also serve as a valuable tool for highway engineers in general and ASTM subcommittees in particular to develop much needed standards.

The editors wish to thank all those who participated in the symposium and who contributed to this STP. Special thanks to the reviewers of the papers, to ASTM Committees D18 and D4 for sponsoring the symposium, and to members of Subcommittees D18.10 and D4.39 for their valuable inputs and efforts. Last but not least, the editors would like to express their deep appreciation to the ASTM staff for their assistance in preparing for this symposium and in the preparation of this STP. The high professional quality of ASTM publications would not be possible without their efforts.

Gilbert Y. Baladi
Professor of Civil Engineering, Michigan State University, E. Lansing, Michigan; symposium cochairman and coeditor

Albert J. Bush III
U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, Mississippi; symposium cochairman and coeditor