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IMPLEMENTING RESILIENT MODULUS TEST FOR DESIGN OF PAVEMENT STRUCTURES IN FLORIDA

PROBLEM STATEMENT

The 1986 AASHTO Guide for Design of Pavement Structures has incorporated the resilient modulus (MR) of component materials into the design process. Considerable attention has also been given to the development of mechanistic-empirical approaches (e.g., the 2002 AASHTO Pavement Design Guide) for design and evaluation of pavements. Both the 1986 Guide and the mechanistic-based design methods use the resilient modulus of each layer in the design process.

Conducting the resilient modulus test and selecting an appropriate resilient modulus value for pavement designs are very complex processes. More than two hundred laboratory triaxial resilient modulus tests on Florida soils have been conducted in the past ten years. These test results have been saved in Microsoft Excel table format. Inconveniences, difficulties, and mistakes have been encountered often in such data maintenance activities as updating, editing, or adding new data, to say nothing of search and analysis, by treating the records as a complete database. In addition, due to the lack of necessary equipment and well-trained technicians to run the resilient modulus test, except at the State Materials Office, district laboratories do not have the capability to carry out the MR testing for pavement design. A database for the resilient modulus test results is needed so that the Florida pavement soils can be categorized and a simplified method may be developed to select a reasonable resilient modulus value for pavement design.

OBJECTIVES

The primary objective of this research was to develop a resilient modulus database (RMDB) of available MR test results for facilitating soil resilient modulus evaluation and pavement design. The research goal was to study the concept and procedures of the database's development with Microsoft Visual Basic 6.0, as well as the application of the database for analyzing the resilient modulus of Florida pavement soils. The influence factors on the resilient modulus by the linear variable differential transducer (LVDT) position and test method (T292-91I or T294-92) were also evaluated for the possibility of further implementation.

FINDINGS

A comprehensive literature review was conducted for the basic database development concepts, including the entities and relationships for the relational database model. The resilient modulus concept and the test procedures of T292-91I and T294-92 were also discussed, especially the resilient modulus measurement and different types of LVDT positions that were involved in the database analysis.

For the development of the database, user requirements were collected and implemented into the database design process. Microsoft Visual Basic 6.0 and Access 2000 were selected as the major development tools. The database was established with a full consideration of convenience, efficiency, data security, and functionality. In addition to the data entry/import, data query, and data edit functions, the RMDB was developed to include strong data communication functions with Microsoft Excel. The test data in Excel file format can be imported into the database, and the data from the database can be printed automatically into an Excel file format with graphical presentations. The data analysis function was another major feature of the database. The general data analysis and the comparative analysis of the RMDB included most common data analysis functions of the soil resilient modulus. The final product of the RMDB was a software package that could be widely distributed.

The desired adjustment factors, which reflect the effects of different test procedures and LVDT positions on resilient modulus values, were determined by applying the functions of comparative analysis and the resilient modulus test data accommodated in the database. The linear regression models were used to determine each type of adjustment factor. Twelve adjustment factors were determined based on the resilient modulus test data from the database.

CONCLUSIONS

The conclusions are summarized as follows:

1. A resilient modulus database (RMDB) was developed using Visual Basic 6.0 and Microsoft Access. The database system was established according to the relational database model. The RMDB was used to determine the resilient modulus adjustment factors.

2. The LVDT positions obviously affect the resilient modulus values. The resilient modulus values measured from the full length LVDT are about 75% (for the T292-91I) or 62% (for the T294-92) of the values measured from the middle length LVDT. The reduction in the resilient modulus value of 25% to 38 % is considered to be due to the effect of LVDT positions.

3. The difference is negligible in the modulus values measured between the middle length LVDTs from the T292-91I and T294-92 test procedures.

4. The difference is very significant (42% to 60% higher) in the modulus values measured from the middle LVDT of the T292-91I test procedure and from the full length LVDT of the T294-92 test procedure.

5. Strong correlation relationships existed in the comparative analysis of the test data. The good correlation showed the quality of the analysis and added to the confidence in the test results.

BENEFITS

This project has resulted in the development of an improved process, which will be included in an updated FDOT Soils and Foundation manual, for handling resilient modulus (Mr) values for use in pavement design in Florida. Prior to the development of the database, there was no practical way to use the stored data analytically. However, the database, particularly as it becomes increasingly populated with data, will become progressively more useful as an analytical tool. The current method for determining Mr is field testing. The database will be useful for determining the most suitable Mr for given projects and so reduce the frequency with which field testing needs to be conducted, which will, in turn, result in cost savings.

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