OHIO DEPARTMENT OF TRANSPORTATION
OFFICE OF PAVEMENT ENGINEERING
RESEARCH IMPLEMENTATION PLAN

Title: Monitoring and Analysis of Data Obtained from Moisture-Temperature Recording Stations/ Extended Monitoring & Analysis of Moisture Temperature Data

State Job Number: 14589/14694
PID Number:
Research Agency: Case Western Reserve University
Researcher(s): Ludwig Figueroa
Technical Liaison(s): Aric Morse, Roger Green
Research Manager: Karen Pannell
Sponsor(s): Howard Wood, David Humphrey
Study Start Date: 8/1/1994 (14589), 5/5/1998 (14694)
Study Completion Date: 6/30/1997 (14589), 12/5/2001 (14694)
Study Duration: 35 Months (14589), 43 Months (14694)
Study Cost: $53,720.00 (14589), $79,448.00 (14694)
Study Funding Type: 80 Federal / 20 State, ODOT SPR (2)

STATEMENT OF NEED:

Variations in the mechanical properties of materials of a flexible pavement affect its response to applied loads in the form of deflections, stresses and stains. The resilient modulus of asphalt concrete and of fine grained subgrade soil vary seasonally as a result of weather related elements such as temperature and rainfall. Knowing the expected variation of layer properties throughout the pavement's service life will lead to more accurate pavement designs when analyzed with a mechanistic/empirical based design procedure.

To study the variations in mechanical properties of the pavement layers due to environmental factors, nine recording stations were installed throughout Ohio to monitor asphalt, subgrade soil, and air temperature; subgrade soil degree of saturation; and rainfall under a research project entitled "Characterization of Ohio Subgrade Types". The sites were selected to include statewide climatic variations and the most prevalent soil types (A-3, A-4, A-6, and A-7). One site was installed the fall of 1991. The remaining sites were installed the spring of 1992. The sites were monitored for a two and half year period under the initial project. Data retrieved from the stations with fine grained soil showed the degree of saturation for the most part was close to 100%, but varied from 80% to 100%.

Further monitoring was needed to verify the initial observed trends in soil saturation and to improve initial developed relationships between air temperature and average pavement temperature.

RESEARCH OBJECTIVES:

- Monitor moisture, temperature, and rainfall at nine recording stations in Ohio for an extended period of time.
- Obtain and analyze seasonal falling weight deflectometer data
- Develop guidelines regarding the use of seasonal resilient properties for mechanistic/empirical pavement design.

RESEARCH TASKS:

1. Data collection and reduction
2. Data analysis and determination of resilient properties of pavement layers
3. Development of implementation guidelines
4. Final report

RESEARCH DELIVERABLES:

1. Final report
2. Implementation guidelines

RESEARCH RECOMMENDATIONS:

- The optimal time for deflection testing (FWD and dynaflect) is between 8:00 a.m. and 10:00 am since the surface layer exhibits a uniform stiffness (no temperature gradient) throughout the thickness of the pavement.
- Maximum temperature gradients occur between 2:00 pm and 4:00 pm and at 6:00 a.m.
- Based on data collected, Ohio may be divided into three general temperature zones for assessing the average asphalt concrete modulus on a seasonal or monthly basis for any future implementation of mechanistic/empirical pavement analysis.
- A method to calculate the resilient modulus of subgrade soils at the break point (Eri) from measured FWD deflections was developed.
- No correlation was found between the rainfalls accumulated over either one month, two or three months preceding the date of FWD testing and the back calculated resilient modulus.

PROJECT PANEL COMMENTS:

These projects, as well as the project entitled “Characterization of Ohio Subgrade Types”, have provided an understanding of the seasonal variation in flexible pavement mechanical properties.

IMPLEMENTATION STEPS & TIME FRAME:

The pavement mechanical properties measured on these projects have been incorporated into the final report for state job number 14767 entitled “Material Properties for Implementation of Mechanistic-Empirical (M-E) Pavement Design Procedures” received in March 2004.

NCHRP will initiated a series of nine projects (NCHRP 1-40) to identify and correct deficiencies in the guide and software, train users, and assist states in the implementation. Two of the projects, the review of the software and the development of local calibration guidelines are scheduled for completion by 2007.

ODOT will initiate a research project, PS-07-04, in fiscal year 2007 entitled “Guidelines for Implementing NCHRP 1-37A M/E Design Procedure in Ohio”. The two year study will use existing data from research projects conducted for ODOT, including these projects, to validate and calibrate the 1-37A software for Ohio and develop guidelines to “fill in the gaps” in the input data required for the 1-37A software.

EXPECTED BENEFITS:

One of the strategic goals of the Office of Pavement Engineering’s strategic research plan is the implementation of M/E pavement design procedures. These projects are two of the projects included in the plan. Benefits of implementing an M-E design procedure include:

- M-E procedures reduce the degree of uncertainty in the design process and provide designs more appropriate to the type of pavement performance expected.

- M-E procedures have the ability to predict the occurrence of individual distresses. Pavements can be designed to resist specific types of distress. The procedures can also increase the accuracy of distress predictions in pavement management systems.
- M-E procedures are forensic tools by analyzing failed pavement using actual materials, properties, climate, traffic, etc., to identify factors responsible for the failure.
- M-E procedures allow rapid analysis of the impact of new materials, changes in traffic loading/configuration, etc. on pavement performance.
- M-E procedures provide the ability to tie together pavement management, design, materials selection, and construction.

The monetary benefit of implementing an M/E design procedure is estimated by FHWA to be $863 million nationally.

EXPECTED RISKS, OBSTACLES, & STRATEGIES TO OVERCOME THEM:

N/A

OTHER ODOT OFFICES AFFECTED BY THE CHANGE:

N/A

PROGRESS REPORTING & TIME FRAME:

There is no need to report on progress until the completion of PS-07-04 entitled "Guidelines for Implementing NCHRP 1-37A M/E Design Procedures in Ohio",. Implementation of the M-E design procedures will begin sometime after completion of PS-07-04. The progress reporting and time frame for implementation of M-E design procedures will be developed in the implementation plan for PS-07-04 with an anticipated to completion in 2009.

TECHNOLOGY TRANSFER METHODS TO BE USED:

The Final Report of the research has been distributed to 49 state transportation departments, different FHWA offices, selected national libraries, and others.

IMPLEMENTATION COST & SOURCE OF FUNDING:

Implementation cost will be developed upon completion of PS-07-04.

Approved By:

Office Administrator(s):

Signature: David Humphrey Office: OPE Date: 12/07/2006

Division Deputy Director(s):

Signature: Howard Wood Division: Planning Date: 12/07/2006