



Office of Innovation, Partnerships & Energy Innovation, Research & Implementation Section

Executive Summary Report

Forensic Investigation of AC and PCC Pavements with Extended Service Life

Start date: January 15, 2006

Duration: 56 months

Completion Date: September 15, 2010

Report Date: September 2010

State Job Number: 134280

Report Number: FHWA/OH-2010/004A

Funding: \$404,571.60

Principal Investigators:

Shad M. Sargand

William Edwards

ODOT Contacts:

Technical:

Roger Green

Administrative:

Jennifer Gallagher, P.E.

Section Leader, IRIS

614-644-5928

for copies of this report, go to:

<http://www.dot.state.oh.us/DIVISIONS/TRANSYSDEV/RESEARCH/REPORTSANDPLANS/Pages/default.aspx>

or call 614-644-8173

Ohio Department of Transportation
Office of Innovation, Partnerships & Energy
1980 West Broad Street
Columbus OH 43223

Problem

The purpose of this research project is to identify flexible, rigid and composite pavements that have not received any structural maintenance since construction and are considered to be performing either average or excellent, and determine reasons why excellent pavements perform better than average pavements. By identifying these reasons and implementing them into standard practice, the overall performance of pavements in Ohio can be improved in the future.

Objectives

The following are primary objectives of this research:

- Review the ODOT pavement database to determine current performance expectations on highway pavements in Ohio. In this statistical analysis, pavements will be divided according to: type of original construction (flexible, rigid and composite); classification (interstate, four-lane non-interstate and two-lane); geographical region in the state; and traffic volume. Composite pavements will be limited to those constructed as such, and not concrete pavements overlaid later with asphalt concrete. Measures upon which performance will be judged include: distress, roughness, age, traffic loading (ESALs), and rutting as a separate criteria on asphalt concrete pavements.
- From the statistical analyses performed in Objective 1, a final selection of ten asphalt concrete (AC) and ten Portland cement concrete (PCC) projects performing as expected, and ten AC and ten PCC projects performing beyond expectations will be made by representatives from the Ohio Department

of Transportation (ODOT), Ohio University (OU), and industry. A few composite pavements may be included, as deemed appropriate. Pavements which appear to be performing poorly in this analysis also will be identified for review by ODOT

- ODOT District Offices responsible for those pavements selected as performing as expected and better than expected will be visited to discuss the selection process and to gain input regarding past performance.
- Inspect each of the selected sites and perform a suite of tests to develop response and performance profiles along the project lengths. These site inspections will include, at a minimum, Pavement Distress Survey (SHRP-P338), Pavement Condition Ratings (PCR), Falling Weight Deflectometer (FWD) readings, Dynamic Cone Penetrometer measurements (DCP), Ground Penetrating Radar measurements (GPR), roughness measurements, lateral profiles on AC surfaces, cores, and the collection of representative material samples.
- Conduct a historical review of each project to determine: age, environmental conditions, original specifications, construction documentation, original test data, traffic volumes and weights accumulated since being opened to traffic, and previous condition information collected by ODOT (PCR,

FWD, ride quality, etc.). Personnel associated with the design and/or construction of the study pavements will be contacted to determine if they recall any particular decisions or events that might have affected performance. ODOT will provide access to the required files and ORITE will search the files for pertinent data.

- Conduct laboratory tests to determine the current physical properties of pavement, base and subgrade materials in the study pavements. Compare these current properties with properties measured at the time of construction. In addition to this battery of standard tests, the PCC cores will undergo an extensive petrographic examination to ascertain compliance with original specifications and current micro structural condition.
- Perform mathematical analyses to assess theoretical structural performance based on distress and thickness using various performance prediction procedures, historical data and in-situ material properties. At a minimum, equations developed under NCHRP 1-26, software developed under NCHRP 1-37A and 1993 AASHTO procedures will be used to predict performance.
- Identify design, construction, and material features which appear to extend pavement life on superior pavements, and recommend procedures for improving the longevity of

pavements in Ohio by implementing these features into practice. Document all work in a final report.

Selected Projects

The limited number of projects available for study did not permit the systematic inclusion of roadway classification, geographical location and traffic as variables in the selection process. The 40 selected flexible and rigid pavement sites, however, represented two-lane, four-lane primary and interstate highways across the state, as well as a range of build-ups and traffic loading. Rigid pavements also had a wide range of joint spacings, and both reinforced and non-reinforced concrete slabs were included. A visual examination of the cores indicated that various aggregate types and sizes were also well represented.

Research Process

FWD and ride quality measurements were run, cores were cut, DCP tests were performed, and samples of the base and subgrade were removed from each site. Flexible and rigid pavement cores, and material samples were sent to the ORITE Lab for testing. Additional rigid pavement cores were sent to Lankard Materials Laboratory for petrographic examination, and additional asphalt concrete cores were sent to the ODOT Central Laboratory for a determination of AC mix properties and aggregate gradations.

These data were reviewed to identify trends which separate flexible and rigid pavements

judged to have average and excellent performance. Because these pavements were all performing as or better than expected, they were considered to be satisfactory and any differences were expected to be slight.

Final documentation of this research project consists of a three volume set of reports.

Conclusions and Recommendations

Among the items recommended to improve pavement performance include: 1) use performance graded asphalt cement, small sized aggregate and polymers when designing surface and intermediate mixes for heavily traveled flexible pavements, 2) maintain uniform stiff subgrades with improved stiffness controls during construction and thicker base layers, and 3) replace some Portland cement with fly ash and use larger aggregate in pavement concrete, while continuing to test for D-cracking susceptibility.

Other observations regarding the data used to reach these conclusions include: keeping the ODOT PMIS database current,

retaining construction records for at least the design life of the pavements, being aware that the effect of surface cracks on flexible pavement performance depends upon whether the cracks are top-down or bottom-up, and the PMIS and straight-line diagrams should be consistent in identifying project limits, project numbers and paving materials.

Implementation Potential

Since pavements selected for study were performing as or better than expected, all were satisfactory and there were no obvious problems that required immediate attention. Rather, the four main findings revolved around the reinforcement of current practices or the recommended consideration of some slight changes in policy.

The first conclusion was to use performance graded asphalt cement, small sized aggregate and polymers for surface and intermediate layers on flexible pavements. This should be especially encouraged on pavements carrying heavy traffic loads. The comparison of Sections 112 and 902 on the Ohio SHRP Test Road provided

clear evidence that the use of these recommendations improve flexible pavement performance. These procedures have been implemented by ODOT with specific adjustments to account for conditions in Ohio.

Subgrade uniformity should be maintained during construction by using the FWD or other stiffness devices as part of the approval process. A standard procedure will need to be established for performing the tests and assigning acceptance criteria. Thicker base layers also provide more uniform pavement support.

Based on examinations of some older rigid pavements and experience gained on the Ohio SHRP Test Road, it would be beneficial to reduce the quantity of Portland cement and incorporate larger sized, D-cracking resistant aggregate in 451 and 452 concrete mixes. The use of supplementary cementitious materials like fly ash should be encouraged in concretes. These changes should be initially tried on an experimental basis and monitored closely to determine if any problems occur.