



Office of Innovation, Partnerships & Energy  
Innovation, Research & Implementation Section  
Executive Summary Report

## MONITORING AND MODELING OF PAVEMENT RESPONSE AND PERFORMANCE TASK B: NEW YORK

Start date: May 1, 2006

Duration: 72 months

Completion Date: May 1, 2012

Report Date: January 2012

State Job Number: 134287

Report Number: FHWA/OH-2012/08

Funding: \$1,584,958.06

Principal Investigators:

Shad M. Sargand

J. Ludwig Figueroa

ODOT Contacts:

Technical:

Roger Green

Administrative:

Jennifer Gallagher

Program Manager

614-644-5928

for copies of this report, go to:  
<http://www.dot.state.oh.us/Divisions/TransSysDev/Research/Pages/default.aspx>  
or call 614-644-8173

Ohio Department of Transportation  
1980 West Broad Street  
Columbus OH 43223

### Problem

Perpetual asphalt concrete (AC) and long-lasting Portland cement concrete (PCC) pavements are relatively new to the pavement community. These newer pavements require the use of innovative Mechanistic-Empirical (ME) design procedures, advanced climatic models, updated specifications, test methods providing detailed material properties, and construction techniques not been entirely adopted into standard practice. Standard practice for rehabilitating distressed highway pavements generally involves the application of AC overlays. When AC overlays are placed on distressed PCC pavements, slab movements cause stress concentrations to develop at joints and cracks, which often results in premature cracks reflecting up through to the surface at these locations. By breaking PCC slabs into smaller pieces prior to overlay, stresses are reduced by distributing the load over a wider area. Instrumentation installed in these pavement sections will provide data regarding measured responses under known environmental and loading conditions.

### Objectives

- (1) Monitor new perpetual AC and long-lasting PCC pavements constructed on US-30 in Ohio, rehabilitated PCC pavements on I-86 in New York, and other existing instrumented pavements in both states,
- (2) Verify ME design procedures for all pavements in the study by comparing theoretical calculations with measured responses and performance,
- (3) Calibrate ME procedures presented in the NCHRP 1-37A AASHTO Pavement Guide for Ohio and New York using data collected in this and other previous studies,
- (4) Conduct controlled testing of perpetual pavement systems to determine their relative performance and to recommend the most promising layer configurations, and
- (5) Document all research findings in a final report.

Within each of these primary objectives were various secondary objectives related to the primary goals.

## Description

The efforts in New York included instrumentation and monitoring of several pavements not listed in the original proposal. In the interest of clarity, each is listed here with a brief discussion of its main purpose.

**Interstate 490, Victor, near Rochester, New York.** This is a JPCP pavement where different spacings and diameters of dowel bars and spacings of tie bars were installed. The objective consisted of determining the effect of the different dowel and tie bar configurations on response and performance due to environmental factors and to applied loads.

**Route 9A, Manhattan, New York City.** This was a pavement at the former World Trade Center site, where two test sections were successfully instrumented to monitor the effect on pavement performance of the large number of heavy loaded trucks that were anticipated to haul away debris from the destroyed towers and bring in construction materials for the Freedom Tower to be erected in its place. LVDTs, strain gages and thermocouples were installed to measure both the environmental effects on the pavement as well as the pavement response due to heavy loading. Initial data was collected during the construction process and immediately afterwards to establish a baseline for further analysis.

**Interstate 86, Angelica and Cuba.** This was a JRCP pavement which were reconstructed with an asphalt concrete (AC) pavement. The Angelica section is a perpetual pavement design intended to last 40 years or more with only minor resurfacing; the Cuba section is the NYSDOT standard AC design. The objective was to monitor the response and performance of the pavement. Both a perpetual pavement section and a standard asphalt pavement following the

standard design were instrumented for comparison.

Data from the typical design section were collected starting in the fall of 2006. Data from the perpetual AC section, which was constructed in September 2008, were collected starting in 2008. Both sections were subjected to wide weather variations and heavy truck loading.

**Interstate 86, Hinsdale, near Olean, in Cattaraugus County, New York.** This was a jointed reinforced concrete pavement (JRCP) that was rehabilitated in 2007 by constructing an unbonded jointed plain concrete pavement (JPCP) overlay. In the test section, three treatments were selected to apply to the existing JRCP before applying the overlay: rubblization, break and seat, or no treatment. The objective of the test was to compare the response and performance of the completed pavement with overlay as a function of the treatment applied to the original JRCP.

**Interstate 90, Weedsport, near Syracuse.** This pavement consisted of JPCP constructed on different bases, namely the standard New York configuration of a cement treated permeable base (CTPB) built on a dense graded aggregate base (DGAB) versus the alternate of a full-depth DGAB. The objective was to determine if there was an effect on the response and performance of the pavement depending on the type of base.

Because of the extensive amount of effort in this project, this report is divided into three volumes as follows: Volume 1: I490, State Route 9A (RT9A), and I86 Asphalt Concrete Pavement, Volume 2: I86 PCC, and Volume 3: I90 PCC.

## Conclusions and Recommendations

**I490 Pavement Response.** A major cause of loss of support was found to be warping due to accelerated moisture loss resulting from high air temperatures and solar radiation during curing. The pavement deformations resulting from these factors may be great enough that the warping may not be reversed by even the most extreme temperature gradients.

**I490 Dowel Bar Arrangements.** The limited data collected in this project indicated that in the short term, the performance of the E2 dowel bar arrangement was better than those of the other two. However, the amount of data from the E2 arrangement in the last set of FWD drops in 2011 was extremely limited (only 2 joints compared to over 20 for the other two configurations), and this is where the difference was largest. An analysis of variance on the dowel bar data indicated that the differences in dowel bar performance were not statistically significant at the 95% level.

A longer-term investigation is needed to determine whether any difference in performance will be maintained as the effects of aggregate interlock diminish over time.

**I490 Tie Bar Arrangements.** Traffic control at the project site did not permit dropping the FWD weight in positions that could gather quantitative data on tie bar performance. Thus the assessment of tie bar performance is limited to qualitative observations from distress surveys. The distress surveys did not show obvious differences between the tie bar treatments. Additional measurements with more traffic control, or at the least an extended period of periodic distress survey collection, are required to differentiate between the treatments.

**RT9A.** The initial installation and data collection were successful. However, on subsequent data acquisition trips, mechanical issues and inability to obtain sufficient traffic control at this busy site prevented the collection of full data sets that could be analyzed for pavement condition. In addition, the wires are still in a temporary pull box waiting to be transferred to the more permanent control box where long term data collection can take place.

**I86 Asphalt Pavement.** As of August of 2011, some minor distresses have been observed in the standard design section, but none that require immediate attention or reconstruction. No distresses have been observed in the perpetual AC design section.

In addition the strain gauges in the perpetual pavement are still intact after more than 3 years of service, about three times the expected service life. The strains measured at the bottom of the asphalt generally are below the design limits for perpetual pavements. These results are generally comparable to those obtained in Ohio on other sites monitored by ORITE, and the perpetual pavement design concept is validated.

**I86 PCC Overlay.** The JPCP overlay over untreated preexisting JRCP experienced a more severe response to environmental factors compared to the overlays placed over broken & seated or rubblized JRCP. Additionally, it can be concluded that at the center of the slab and mid-span along the wheel paths, the breaking and seating of the preexisting concrete would lower the change in strains and stress to values comparable to those experienced using a rubblized base. Based on the results and analysis presented, it is recommended to use one of these fracturing techniques, rubblization or breaking and seating, before placing a JPCP overlay.

The untreated section generally experienced a slightly smaller dynamic response compared to the other two sections, but results were comparable for all treatments. The FWD test results showed that the untreated section typically experienced the lowest deflections while the C&S and rubblized sections showed the highest values at the right wheel path and slab's centerline respectively. These results are sensitive to the location and placement of the FWD. The dynamic responses are also considerably smaller in magnitude than the environmental responses.

It is thus recommended that existing PCC pavement should not be left untreated before applying an overlay. If the subgrade is weak, the break and seat approach is recommended. If the subgrade is strong, the rubblization method is better. The treatment cost should also be considered.

#### **I90 General Conclusions.**

The environmental analysis indicates that the pavement placed on CTPB initially has smaller deflections than the pavement placed on DGAB. However, over time, the bond at the slab/base interface deteriorated such that the pavement deflections of the CTPB section surpassed those of the DGAB section. The truck testing has proven that there was a loss of support at the transverse joints in the CTPB section, which resulted in greater joint deflections under traffic loads. Thus the DGAB provided more uniform slab support, which resulted in lower strains and deflections in the pavement.

The CTPB layer increased slab surface tensile strains and joint deflections, compared to those of the DGAB section. The impact of higher slab strains and edge deflections is an increased risk of mid-slab cracking due to fatigue loading, and structural breaks at the joints due to a loss of support. Therefore, the CTPB had no

positive influence on the pavement and had negative impacts on the load response. The subgrade moisture under the two sections was similar.

### **Implementation Potential**

**I490 Dowel and Tie Bar Arrangements.** Further study is recommended to determine long-term performance before proceeding with implementation.

**I86 Perpetual Pavement Overlay.** Perpetual pavements can be built in New York as needed. The design elements and specifications used in these pavements could be adapted to create new specifications, standard drawings, and other documents needed to establish perpetual AC pavements as specific bid items that could be required for particular projects.

**I86 Existing PCC Pavement Treatment Method.** The New York State Department of Transportation should make sure specifications are in place for break and seat and rubblization procedures. Then one of these procedures, as recommended above based on the strength of the subgrade, should be incorporated into the design and construction of any PCC pavement overlay project.

**I90 PCC Pavement Base Selection.** It is recommended to utilize a DGAB base under PCC pavements instead of CPTB. The NYSDOT can specify DGAB as a preferred, base material in plans and specifications pertaining to JPCP pavements.