

# OHIO DEPARTMENT OF TRANSPORTATION OFFICE OF PAVEMENT ENGINEERING RESEARCH IMPLEMENTATION PLAN



**Title:** Application of High Performance Concrete in the Pavement System/Structural Response of High Performance Concrete Pavements

**State Job Number:** 14666/14696

**PID Number:**

**Research Agency:** Ohio University

**Researcher(s):** Dr. Shad Sargand

**Technical Liaison(s):** Roger Green, Aric Morse, Brad Young

**Research Manager:** Karen Pannell

**Sponsor(s):** Howard Wood, David Humphrey

**Study Start Date:** 11/4/1996:3/30/1998

**Study Completion Date:** 3/15/2002

**Study Duration:** 64/48 months

**Study Cost:** \$163,476: \$95,543

**Study Funding Type:** 100% Federal: (80% Federal/20% State)

## **STATEMENT OF NEED:**

The addition of ground granulated blast furnace (GGBF) slag cement to concrete mixes increases strength, reduces permeability, provides resistance to freezing and thawing, and provides resistance to sulfate attack. In these studies, GGBF slag cement was added to the concrete pavement mix as a 25% replacement of the cement. The influence of GGBF slag cement on the mechanical properties of concrete and its effect on strains within the pavement were investigated in these studies. The mix was used in the construction of a new concrete pavement on US 50 in Athens County. The pavement was instrumented to investigate pavement response to loading and environmental change.

## **RESEARCH OBJECTIVES:**

- Determine influence of GGBF slag cement on the setting process of pavements.
- Evaluate performance of pavement containing GGBF slag cement due to environmental factors and dynamic loadings.
- Determine the effect of addition of GGBF slag cement on the mechanical properties of concrete.
- Compare the cost of pavement constructed using GGBF slag cement to pavement constructed using Portland cement.
- Monitor joint openings due to environmental factors.
- Monitor the moisture in the subgrade under the joints and the center of slabs.
- Determine the initial shape of the concrete slab.
- Determine the total stress in the concrete.

## **RESEARCH TASKS:**

### Application of High Performance Concrete in the Pavement System

- Monitor construction to identify any problems with workability, set time, etc.
- Investigate set time using thermocouples and maturity concept.
- Determine flexural strength and compressive strength of control mix and GGBF slag cement mix at 1, 2, 3, 7, 14, 28, 90 and 365 days.
- Analyze FWD data collected by ODOT.
- Monitor the shape of the slabs containing GGBF slag cement and the control concrete mix.

### Structural Response of High Performance Concrete Pavements

- Install TDR probes to monitor the moisture in the subgrade under joints and center of the slabs.
- Install strain gages in the concrete slab to monitor strain during FWD testing.
- Monitor slab curl.
- Validate the HIPERPAV software with lab data and field measurements.

### RESEARCH DELIVERABLES:

- Workshop addressing the construction process, collection of data, and analysis of data.
- Final report.

### RESEARCH RECOMMENDATIONS:

- ODOT should consider adopting HIPERPAV in conjunction with the maturity technique to reduce the occurrence of early cracking and to improve the performance of concrete pavement.
- Do not use stiff base materials, such as the Type NJ non-stabilized drainage base and the cement treated free draining base, under concrete pavement.
- The upper range of the Iowa base gradation is similar to the New Jersey base gradation and should not be used under PCC pavement.
- ODOT should collect additional data to determine the effectiveness of sealing the joints in concrete pavement.

### PROJECT PANEL COMMENTS:

A cold front passed through the area during construction of the pavement which provided an excellent opportunity to validate HIPERPAV. Transverse cracking predicted by the software corresponded very well with cracking experienced in the field.

The early cracking of the slabs placed on the type NJ free draining base confirmed observations on other projects. As concluded in this study, the cracking is likely due to the densification of the type NJ base and the resulting loss of support under the slab.

The moisture under the sealed pavement joints was found to be the same or higher than the moisture under unsealed joints, possibly due to the sealants trapping the moisture under the pavement.

### IMPLEMENTATION STEPS & TIME FRAME:

- HIPERPAV analysis is required prior to placing concrete pavement per Item 451.08 of the 2005 ODOT Construction and Material Specifications.
- The Division of Highway Operations issued a moratorium on the use of free draining bases, including the New Jersey and Iowa gradations, on March 21, 2001.
- While this study was ongoing, the Ohio Concrete Pavers Association submitted a request to remove the joint sealing requirement from the specifications. As a result of information presented with that request, Wisconsin's experience, and the preliminary observations on this study, the following steps will be or have been taken:
  - The sealing of transverse joints is a contractor option for concrete pavements constructed under ODOT's warranty (SS 884), QC/QA specification (SS 888), and QC/QA with warranty specification (896).
  - OPE will request a proposal note removing the sealing requirement from Items 451 and 452 be included on future projects.
  - OPE will request the joint sealing requirement will be removed from Items 451 and 452 during the next revision of the Construction and Material Specifications.

**EXPECTED BENEFITS:**

The use of HIPERPAV will provide the contractor guidance for scheduling pavement joint sawing and will reduce the occurrence of unwanted cracks in concrete pavement during the first 72 hours after placement.

The moratorium on the free draining bases prevented the construction of additional concrete pavements with the potential for premature failure.

As documented in the implementation plan for “Ohio Route 50 Joint Sealant Experiment”, state job number 14668, the benefit/cost ratio for not sealing joints in concrete pavement is 31.

**EXPECTED RISKS, OBSTACLES, & STRATEGIES TO OVERCOME THEM:**

None

**OTHER ODOT OFFICES AFFECTED BY THE CHANGE:**

None

**PROGRESS REPORTING & TIME FRAME:**

HIPERPAV and the moratorium on free draining bases have been implemented and no further reporting is necessary.

Progress on implementing the results of research concerning sealing of joints in concrete pavements will be reported under the implementation plan for “Ohio Route 50 Joint Sealant Experiment”, state job number 14668.

**TECHNOLOGY TRANSFER METHODS TO BE USED:**

- An open house and workshop was conducted on August 15-16 at the Ohio University Inn in Athens, Ohio. The open house and workshop was attended by 96 people from 15 different states.
- 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:**

N/A

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**Approved By:** (attached additional sheets if necessary)

**Office Administrator(s):**

Signature: David Humphrey Office: OPE Date: 2/10/2006

**Division Deputy Director(s):**

Signature: Howard Wood Division: Planning Date: 2/14/2006