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

**Title:** Performance of Dowel Bars and Rigid Pavement

**State Job Number:** 14667
**PID Number:**
**Research Agency:** Ohio University
**Researcher(s):** Shad Sargand, Glen Hazen
**Technical Liaison(s):** Roger Green
**Research Manager:** Karen Pannell
**Sponsor(s):** Howard Wood, David Humphrey
**Study Start Date:** 11/4/1996
**Study Completion Date:** 7/30/2001
**Study Duration:** 57 Months
**Study Cost:** $214,594.00
**Study Funding Type:** 100% Federal, FHWA

## STATEMENT OF NEED:

The performance of Portland cement concrete joints in transferring traffic loads to adjacent slabs is influenced by several factors, including temperature and moisture distributions within the slabs, physical properties of the base and subgrade underlying the pavement, moisture content of the subgrade, and the type, size and spacing of dowel bars. Finite element methods have been used with some success in analyzing concrete pavement systems containing joints and cracks. The accuracy of these methods, however, depends on how realistically the properties can be modeled. These procedures must then be verified and calibrated with data obtained on in-service pavements. To date, stresses induced in dowel bars and concrete slabs from environmental cycling and dynamic loading have not been determined in the field.

## RESEARCH OBJECTIVES:

Evaluate dowel response under a variety of loading and environmental conditions in the field; compare the measured responses of different types of dowel bars.

## RESEARCH TASKS:

On US Route 50, five miles east of the City of Athens, Ohio, the response of fiberglass, epoxy coated steel, and grout-filled stainless steel dowel bars were evaluated and compared under a variety of loading and environmental conditions. The research tasks are as follows:

1. Instrument standard epoxy coated steel, grout filled stainless steel tubes, and fiberglass dowel bars for the monitoring of strain induced by curing, changing environmental conditions, and applied dynamic forces.
2. Install these dowel bars in an actual PCC pavement at the time of construction.
3. Record strain measurements periodically over time to determine forces induced in the dowel bars during curing and during changing environmental conditions.
4. Evaluate strain histories recorded for this in-service pavement.

**RESEARCH DELIVERABLES**:

- The final report will describe all research activities, findings, and conclusions.

**RESEARCH RECOMMENDATIONS**:

Based on field data obtained from the instrumented dowel bars during environmental cycling, steel dowel bars experienced higher bending moments across transverse PCC joints than fiberglass dowel bars. Both types of dowel bars experienced a permanent bending moment in the PCC pavement slab during curing. The magnitude of this moment appears to be a function of dowel bar stiffness. Curling and warping during the first few days after concrete placement can result in high bearing stress being applied to the concrete around the dowel bars. This stress may possibly exceed the allowable bearing stress of the concrete at that early age and resulting in some permanent loss of the contact around the bars. From the FWD tests results, the magnitude of bending moments and vertical shear forces transferred by steel dowels across transverse PCC joints were much higher than fiberglass bars of the same size. Overall, both steel and fiberglass dowels experienced higher moments from environmental factors than from dynamic loading.

**PROJECT PANEL COMMENTS**:

The composite and stainless steel tubes are more expensive than the epoxy coated steel dowel bars. The long term performance of the dowel bars in this project and other projects constructed with test sections should be monitored to determine if any of the alternative dowel bar materials are cost effective.

**IMPLEMENTATION STEPS & TIME FRAME**:

- Evaluate the performance of the various dowel bars after 7 years of service. This evaluation will be completed under the project entitled "Evaluation of Pavement Performance on DEL-23" which has a completion date of February 9, 2006.
- Evaluate the condition of epoxy coated steel dowels which have been in service for a long period of time. ODOT first installed epoxy coated dowels in 1971. Projects which had epoxy coated dowel bars installed in the mid 1970's will be identified and the bars will be cored by ODOT to determine the condition of the epoxy coating and the steel dowel bars. Dowel bar test section on JAC/GAL-35 will also be cored. This work will take place during the summer of 2006.
- Perform an analysis of cost effectiveness. This work should be accomplished under pooled fund TPF-5(028), "Evaluation of Alternative Dowel Bar Materials"

**EXPECTED BENEFITS**:

The delays and cost of maintaining traffic during rehabilitation has led many states DOT's to consider pavements designed for long term service lives of 40 or more years. Based on preliminary investigations by several states, there is concern about the long term performance of epoxy coating on steel dowel bars. This has led many states to investigate the use of composites or stainless steel dowels to achieve a long service life. The preliminary results of this study, the composite dowel bars may have the benefit of having a low modulus which minimizes the dowel bar bearing stress on the concrete during curling and warping.

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

The industry has not been able to cost effectively mount composite dowel bars in dowel baskets. Several dowel baskets designs have been developed by one manufacturer but these designs have not been robust enough for use.

The pooled fund TPF-5(028), "Evaluation of Alternative Dowel Bar Materials", is administered by ASCE's HITEC. At the current time, phase 1 of the two phase project is complete and work has been stopped due to lack of funding.

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

None

**PROGRESS REPORTING & TIME FRAME**:

The performance of the test sections is being monitored under the research project "Evaluation of Pavement Performance on DEL-23" which has a completion date of February 9, 2006. A progress and reporting time frame will be established upon completion of this project.

**TECHNOLOGY TRANSFER METHODS TO BE USED**:

- The final report of this research will be available online at the ODOT website.
- The Final Report was also distributed to all other state departments of transportation in addition to national libraries and repositories.

**IMPLEMENTATION COST & SOURCE OF FUNDING**:

Additional funding will be needed to complete phase 2 of TPF-5(028). The amount of funding unknown at this time but should not exceed $100,000. Final funding level will depend on the number of states participating. Funding may also be needed obtain external assistance in coring and evaluating in service dowel bars. The estimated cost of this work is $20,000.

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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