TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): ____IOWA DOT_____

INSTRUCTIONS:

Project Managers and/or research project investigators should complete a quarterly progress report for each calendar quarter during which the projects are active. Please provide a project schedule status of the research activities tied to each task that is defined in the proposal; a percentage completion of each task; a concise discussion (2 or 3 sentences) of the current status, including accomplishments and problems encountered, if any. List all tasks, even if no work was done during this period.

Transportation Pooled Fund Program Project # *TPF-5(183)*	**Transportation Pooled Fund Program - Report Period:** X Quarter 1 (January 1 – March 31) Quarter 2 (April 1 – June 30) Quarter 3 (July 1 – September 30) Quarter 4 (October 4 – December 31)

Project Title: Improving the Foundation Layers for Concrete Pavement		
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Lead Agency Project ID: RT 0314	**Other Project ID (i.e., contract #):** Addendum 352	**Project Start Date:** 3/16/09
Original Project End Date: 3/15/14	**Current Project End Date:** 3/15/20**14**	**Number of Extensions:**

Project schedule status:

X On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Overall Project Statistics:

Total Project Budget	Total Cost to Date for Project	Total Percentage of Work Completed
$700,000	$376,188	85

Quarterly Project Statistics:

Total Project Expenses This Quarter	Total Amount of Funds Expended This Quarter	Percentage of Work Completed This Quarter
$16,705		10

Project Description:

The objective of this research is to improve the construction methods, economic analysis and selection of materials, in-situ testing and evaluation, and development of performance-related specifications for the pavement foundation layers. The outcome of this study will be conclusive findings that make pavement foundations more durable, uniform, constructible, and economical. Although the focus of this research will be PCC concrete pavement foundations, the results will likely have applicability to ACC pavement foundations and, potentially, unpaved roads. All aspects of the foundation layers will be investigated including thickness, material properties, permeability, modulus/stiffness, strength, volumetric stability and durability. Forensic and in-situ testing plans will be conceived to incorporate measurements using existing and emerging technologies (e.g. intelligent compaction) to evaluate performance related parameters as opposed to just index or indirectly related parameter values. Field investigations will be conducted in each participating state. The results of the study will be compatible with each state's pavement design methodology and capable for use with the Mechanistic-Empirical Pavement Design Guide (MEPDG). Evaluating pavement foundation design input parameters at each site will provide a link between what is actually constructed and what is assumed during design. There are many inputs to the pavement design related to foundation layers and this project will provide improved guidelines for each of these. The study will benefit greatly from maximizing the wide range of field conditions possible within the framework of a pooled fund study.

Progress this Quarter (includes meetings, work plan status, contract status, significant progress, etc.):

The main research activities during this quarter involved the following [related research task number is in the parenthesis]:

- Conducting laboratory testing on samples obtained from the field projects [Sub Task 1.5],
- Conducting in-situ test data analysis on field projects and developing field project reports [Sub Tasks 1.5, 1.7, 3.1, 3.2, 3.4,]
- Obtaining temperature sensor array data on Iowa Hwy 30 project and conducting in-situ testing [Sub Task 3.1].

Laboratory testing:

Cyclic triaxial tests according to NCHRP598 loading sequences and M_r testing according to AASHTO T-307 and the data analysis have been completed. Permanent strain and resilient modulus provide direct, quantifiable values that describe two types of deformation (irrecoverable and recoverable) of pavement foundation materials under repeated transient traffic loads and provide an estimate of pavement system performance. Although the permanent deformation is not directly used in pavement design, they practically indicate the long-term performances of pavement foundations. The resilient moduli are used in AASHTO 1993 pavement design and the current Mechanistic-Empirical Pavement Design Guide. This laboratory study investigated permanent deformation and resilient modulus of unbound granular materials (UGMs) separately in relation to relative densities, fines contents, material types, stress levels, and number of load applications. Materials tested included crushed limestone and recycled materials (recycled asphalt pavement and recycled portland cement concrete).

Key findings from this laboratory study are that 1) accumulation of permanent deformations increase with deviator stress; 2) higher fines contents (about 12%) result in high permanent deformations; 3) relative density in the range of 85% to 95% does not significantly affect permanent deformation behavior; 4) the crushed limestone material tested in this study had higher resistance to permanent deformation and higher resilient moduli compared to the recycled materials tested in this study; 5) the two recycled materials tested in this study generally have the similar resilient modulus values; 6) stress levels (confining pressure and deviator stress) significantly affect the resilient moduli and generally higher stress levels result in higher resilient moduli; and 7) relative densities and fines contents affect the resilient moduli but they are not clearly related. Due to the complexity of the test methods used in this study, measurement error related to data sampling, tests apparatus setup, and the analysis methods were studied. This analysis demonstrated that 200 minimum readings are not sufficient in tracking the loading history and selection

of data points affects the calculated resilient modulus value at each load sequence in the resilient modulus tests.

Instrumentation on US Highway 30, Iowa*:*
A summary of instrumentation installed on the US30 project is provided in the last QPRs. In brief, a temperature array with fourteen sensors to continuously record temperature changes both across the pavement width and in the foundation layers with depth was installed at the project site. A Campbell Scientific CR5000 data logger was installed on site to continuous record the temperature in the foundation layers at one hour intervals.

One of the main objectives of this instrumentation was to identify temperature fluctuations in the foundation layers with depth and across the pavement, and to assess thermal shielding of road edge due to snow cover. Temperature data is being collected since fall 2011 and is being currently analyzed.

Research Team Meeting:
The research team had a team meeting at TRB in January to review the manual of practice outline, discuss the technical data reports, and outline ideas for key illustrations for the final report. A plan was set to provide internal review comments from the team.

Anticipated work next quarter:

- Complete data analysis for the field projects and update field project reports.
- The "Manual of Practice" report will the reflect changes discussed by the project team at the January team meeting at TRB.

Significant Results:

Some of the reports listed below, although have been drafted during the previous quarter, they have been updated during this quarter.

- MI I-96 project – This project consisted of 11 in. PCC, 5 in. cement treated base layer, 11 in. sand subbase layer (geotextile separator at CTB and subbase interface), and subgrade.
- WI US-10 project – This project consisted of 10 in. PCC, 6 in. dense graded base, 24 in. sand subbase layer, subgrade.
- MI I-94 project – This project consisted of 11 in. PCC, 27 in. open graded drainage course with geotextile separation layer at subgrade/base interface on the new pavement. An old pavement on the project site was also tested which consisted of 9 in PCC, 4 in. gravelly sand base, and 12 in. sand subbase, and silty clay subgrade
- IA I-29 project – This project consisted of 11 in., PCC, 6 in. base layer with recycled PCC material, 18 in. of special backfill with recycled asphalt material, and subgrade.
- MEPDG Sensitivity Analysis Report by UofI.
- Finite Element Analysis with Non Uniform Support Conditions Report by UofI.

Circumstance affecting project or budget (Describe any challenges encountered or anticipated that might affect the completion of the project within the time, scope, and fiscal constraints set forth in the agreement, along with recommended solutions to those problems).

None.