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:** Quarter 1 (January 1 – March 31) Quarter 2 (April 1 – June 30) X Quarter 3 (July 1 – September 30), 2012 Quarter 4 (October 4 – December 31)

Project Title: Improving the Foundation Layers for Concrete Pavement		
Project Manager: David White	**Phone:** 294-1463	**E-mail:** djwhite@iastate.edu
Project Investigator: David White	**Phone:** 294-1463	**E-mail:** djwhite@iastate.edu

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:** 3/15/2014	**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	$319,552.54	75

Quarterly Project Statistics:

Total Project Expenses This Quarter	Total Amount of Funds Expended This Quarter	Percentage of Work Completed This Quarter
$21,611.84		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 (frost-heave/thaw-weakening) on samples obtained from the field projects [Sub Task 1.5],
- Conducting in-situ test data analysis on three field projects (Iowa I-35, Michigan I-96, Wisconsin US10, Iowa I-29, and Pennsylvania SR-22) and developing field project reports [Sub Tasks 1.5, 1.7, 3.1, 3.2, 3.4,]
- Conducting field testing on a project on US34 near Ottamwa, Iowa. [Sub Task 1.5].
- Conducting performance evaluation using M-EPDG and finite element methods [Sub Task 2.3]
- Obtaining temperature sensor array data on Iowa Hwy 30 project and conducting in-situ testing [Sub Task 3.1].

<u>Laboratory testing:</u>

As indicated in the last QPRs, the following materials have been selected to conduct comprehensive laboratory testing:

A. western Iowa loess,
B. chemically treated western Iowa loess (with fly ash and cement),
C. recycled asphalt pavement (RAP) base material (with varying fines content: 0%, 6%, 12%, natural fines content),
D. crushed limestone base material (with varying fines content: 0%, 6%, 12%, natural fines content),
E. recycled portland cement concrete (RPCC) base material (with varying fines content: 0%, 6%, 12%, natural fines content),
F. concrete sand
G. pea gravel
H. composite RPCC material + loess (with and without geosynthetic reinforcement)
I. composite RAP material + loess (with and without geosynthetic reinforcement)
J. composite crushed limestone material + loess (with and without geosynthetic reinforcement)

Update for each of the laboratory test is as follows:

A. Laboratory classification tests (i.e., specific gravity, Atterberg limits, grain size distribution, soil classification, and natural moisture content – Completed for all materials listed above.

B. Moisture-density relationship (i.e., using Proctor tests for non-granular materials and vibratory compaction tests for granular materials) – Completed for all materials listed above.
C. Cyclic triaxial tests according to NCHRP598 loading sequences and Mr testing according to AASHTO T-307 – M_r and permanent deformation (NCHRP 598) tests for three types of materials (Materials C, D, and E). Tests were conducted on materials compacted to 85%, 90%, and 95% relative density, and varying fines content (0%, 6%, and 12% passing No. 200 sieve), to evaluate their influence on M_r and permanent deformation properties.
D. Horizontal permeability test (HPT on a 113 cm L x 54 cm W x 30 cm H sample) – HPTs have been completed on materials C, D, E, F, and G.
E. Gas permeability test (GPT) (on HPT samples) – GPTs have been completed on materials C, D, E, F, and G.
F. Core hole permeability (CHP) test (on HPT samples) – CHP tests have been completed on materials C, D, E, F, and G.
G. Light weight deflectometer test (on HPT samples) – LWD tests have been completed on materials, C, D, E, F, and G.
H. Dynamic cone penetrometer test (on HPT samples) – LWD tests have been completed on materials, C, D, E, F, and G.
I. Freeze-thaw durability test, California bearing ratio tests, and unconfined compressive strength tests –The main emphasis this quarter was to compile and analyze the 2in X 2in and durability test results that have been collected during previous quarters. An additional 12 additional 2in X 2in stabilized samples were made this quarter to verify the accuracy of a portion of the results collected during the previous quarter. Vacuum saturation was performed on 6 of the samples, to represent the strength after several freeze-thaw cycles had occurred. Compressive strength tests were performed on the samples.

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. Data is being periodically downloaded from the project.

Field testing on US Highway 34 in Ottumwa, Iowa:
The project consisted of four lane divided highway pavement with PCC surface and is located just west of Ottumwa, Iowa. Iowa DOT district engineers were interested in testing over a mile long section at this location which has been showing poor ride quality (with progressively decreasing ride quality) over the past few years. Some sections of pavement in that stretch experienced longitudinal cracking and faulting at joints/cracks, while some sections did not. The embankment construction for this pavement involved cuts and fills of up to 30 ft. FWD testing and crack mapping was conducted on this site on each panel over a ¾ mile long section of interest. Test results from this site are being analyzed.

Field data to conduct performance evaluation using M-EPDG and finite element analysis:
The UI research team completed the M-EPDG sensitivity and finite element analysis reports. Both reports are in final review stage by the UI research team and is anticipated to be submitted to the ISU research team early next quarter.

Anticipated work next quarter:

- Continue frost-heave and thaw-weakening testing (emphasis on stabilized materials), and aggregate degradation tests, and finish analysis of laboratory test results.
- Continue frost-heave (with emphasis on stabilized materials), CBR, cyclic triaxial, and aggregate degradation testing on samples collected from all field project sites.
- Complete data analysis for the field projects and develop project reports

Significant Results:

The following research report drafts have been completed 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 only 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
- 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).