Quarterly Progress Report – July 2010
For the period April 1, 2010 to June 30, 2010
TPF-5(183)

Project Dates: August 17, 2009 – August 16, 2011

Project Title: Improving the Foundation Layers for Concrete Pavement (WO 18)

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Progress Report:

Project is on schedule	Yes
Project is within budget	Yes
Significant changes in project description	No

Problems (current or anticipated):

Products and tangible results this quarter (reports/articles written, oral reports/interviews given):

Interaction with Technical Monitor and/or Project Advisory Committee:

Brief summary of this quarter's research and activities pertaining to the project:
Significant progress was made this quarter to develop the project reports for field test sites in PA, MI, WI, IA, and CA. The design of a new large scale lateral flow permeameter has been finalized and is currently is in the fabrication process. Laboratory test procedures to evaluate drainage conditions for layered or composite materials including geosynthetics and materials obtained from field project were developed. Preliminary results were studied using MEPDG pavement analysis approach to evaluate impacts of pavement foundation support conditions.

The main research activities during this quarter involved the following [related research task number is in the parenthesis]:
• Conducting a follow-up performance monitoring testing on the Pennsylvania SR-422 project [Sub Tasks 3.1 and 1.5],
• Conducting field testing on three new project sites (Pennsylvania SR-422 project, Michigan I-96 project, Wisconsin US-10 project, and California I-15 project) [Sub Tasks 3.1, 1.5, and 1.7],
• Conducting laboratory testing (characterization and resilient modulus) on samples obtained from the field projects [Sub Task 1.5],
• Design and fabrication of laboratory large scale lateral flow permeameter [Sub Task 1.5],
• Conducting in-situ test data analysis from four 2009/2010 field projects (Pennsylvania SR-422, Iowa I-29, Michigan I-94) and preparing field project reports [Sub Tasks 3.1, 1.5, and 1.7],
• Conducting periodic performance testing in Iowa at 6 project sites [Sub Task 3.1],
• Reviewing seasonal temperature variation data in pavement foundation layers on several project sites in Iowa [Sub Tasks 3.1 and 3.2], and
• Adding new documents to the literature review.

Performance monitoring testing on Pennsylvania SR-422 project: Testing performed on the SR-422 project where the pavement base layer was stabilized using injected light weight foam fill project, was described briefly in the April quarterly progress report (QPR). The base stabilization was performed on the project between September and November 2009. Follow-up performance monitoring testing was conducted on April 28, 2010 (i.e., about five months after foam stabilization) on two test sections with foam stabilization to evaluate the changes in the load transfer efficiency (LTE) at the joints and cracks, pavement surface deflections under falling weight deflectometer (FWD) dynamic loading, and base/subbase/subgrade layer properties (from FWD deflection basin data). A draft data analysis report summarizing the field and laboratory testing results has been prepared and is currently being internally reviewed by the research team.

A 500 ft long section on the project was stabilized using cementitious grout on May 3-4, 2010. Testing on this section prior to stabilization was completed during our initial field visits (in October and November 2009) and a field visit to conduct testing after stabilization is scheduled for July 20, 2010. The project draft report will be updated with the grout stabilized section results and will be submitted for review by the TAC members.

Field testing on 2010 project sites: The main objectives of field testing were to: (a) characterize the strength, stiffness, and permeability characteristics (using various in-situ QC/QA testing methods) of existing and new pavement foundation layers and (b) document the current construction QC/QA procedures. Field testing was conducted using a variety of in-situ test measurements: falling weight deflectometer (FWD) tests, light weight deflectometer (LWD) tests, and static plate load test (PLT) to measure stiffness/modulus, dynamic cone penetrometer (DCP) tests to measure strength/California bearing ratio (CBR), nuclear gauge (NG)tests to measure moisture and dry density, and in-situ gas permeameter tests (GPT) to measure permeability, and shelby tube samples (of subgrade) to determine laboratory resilient modulus and shear strength properties. Brief summary information, field testing and data analysis performed for each project site are as follows:

I-96 Lansing, MI: This project involved reconstruction of about 4 miles of interstate highway near Lansing, MI. The reconstruction process included removal of the old PCC surface layer, and construction of a 11.5" non-reinforced PCC surface layer over 5 inch thick cement treated base (CTB) layer, and existing granular subbase sand and sandy clay subgrade layers. The old pavement was about 9 inches thick. The ISU research team was present on the project site from May 17 to 23, 2010 to conduct field evaluations. In-situ testing on the project involved obtaining FWD, LWD, PLT, NG, DCP, and GPT measurements on three test sections. In-situ test measurements were obtained in a dense grid pattern on one test section with sandy subbase material and one test section with CTB. Results from this test section are being analyzed to characterize the spatial "uniformity" of the foundation layer strength/stiffness/ density/moisture content/permeability properties and spatially visualize the results. The research team is currently working on finishing up a project report documenting the field test results, photos, and the construction procedures.

US10 Steve Point, WI: This project involved new construction of about a 7 mile state highway section near Steve Point, WI. The construction involved compacting cohesive subgrade clay fill material, 24 inch thick sand subbase, and 6" thick granular subbase foundation layers to support 11 inch thick PCC pavement surface layer. The ISU research team was present on the project site from May 24 to 27, 2010 to conduct field evaluations. In-situ testing on the project involved obtaining FWD, LWD, PLT, NG, DCP, and GPT measurements on three test sections. In-situ test measurements were conducted in a dense grid pattern on one subgrade clay layer test section. Results from this test section are being analyzed to characterize the spatial "uniformity" of the foundation layer strength/stiffness/ density/moisture content properties and spatially visualize the results. As part of one test section, FWD testing was conducted on the new PCC surface layer and DCP testing was conducted in the underlying foundation layers. The research team is currently working on finishing up a project report documenting the field test results, photos, and the construction procedures.

I-15 Ontario, CA: This project involved reconstruction of about a 1 mile interstate highway section near Ontario, CA. The construction involved placing 8 inch super-slab precast PCC panels over 2" thick leveling sand and the existing 12" to 18" thick cement treated base layer. The ISU research team was present on the project site from June 26 to 30, 2010 to conduct field evaluations. In-situ testing on the project involved obtaining FWD measurements on the existing and new PCC surface layer and FWD and DCP measurements in the foundation layers. The research team is currently working on finishing up a project report documenting the field test results, photos, and the construction procedures.

Laboratory testing: Laboratory testing involved performing soil classification related tests (e.g., grain size distribution, Atterberg limits, Proctor tests, and specific gravity tests) on samples collected from field project sites, resilient modulus tests, and a feasibility study on mixtures of recycled aggregate + subgrade soils. Twelve resilient modulus and quick shear tests were performed on sand subbase and clay subgrade materials obtained from the Wisconsin US-10 project. Four inch diameter composite samples prepared by placing the compacted subbase over the compacted subgrade, as well as individual samples of each material, were tested.

Sixteen resilient modulus and quick shear tests were performed on sand subbase and silty clay subgrade materials obtained from the Michigan I-96 project. Individual and composite specimens of the subbase and subgrade were tested. The composite samples include specimens with compacted subbase over subgrade and specimens with a geosynthetic layer between the subbase and subgrade. Resilient modulus and quick shear tests were performed on two 2.8 inch diameter Shelby tube samples obtained from the subgrade. Composite samples of recycled portland cement concrete (RPCC) over recycled hot mix asphalt (RHMA), sandy gravel backfill over silty clay, and RHMA over silty clay from the Iowa I-29 project were tested as composite samples to simulate the newly constructed pavement foundation. Composite specimens were also prepared with subbase sand and silty clay to simulate the excavated pavement foundation. Nine resilient modulus and quick shear tests were performed on two types of clay subgrades and class 2A subbase materials from the Pennsylvania SR-22 project. Composite samples of the CTB over class 2A material and asphalt treated base (ATB) over class 2A material were also tested. The class 2A material had a maximum particle size of 1.5 inches. Resilient modulus testing on 4 inch diameter samples requires using material passing ¾ inch particle size. Testing was performed on 100% material passing the ¾ inch. A 10,000 cycle resilient modulus test was performed on one specimen of class 2A material. Three resilient modulus and quick shear tests were performed on the clay subgrade material obtained from the Michigan I-94 site. Testing was performed on composite samples of untrimmed base material over clay subgrade. The untrimmed base material had a maximum particle size of 1.5 inches. Therefore, testing was conducted on material passing the ¾ inch sieve (material retained on the ¾ inch sieve was scalped and replaced). The results from this testing are being analyzed and will be included in the respective field project reports.
Laboratory characterization tests have been completed for all Michigan I-96. Atterberg limits have been completed and grain size distributions are in progress for the Wisconsin US-10 materials. Standard and modified Proctor compaction testing has been completed for sand subbase and clay subgrade materials from the I-96 and US-10 projects. Relative density testing has been completed for the sandy subbase materials obtained from I-96 and US-10 projects. Results for all characterization tests and moisture-density relationships will be included in the respective project reports.

Laboratory large scale lateral flow permeameter: An overview of the new laboratory large scale lateral flow permeameter was provided in the April QPR. The design of the device has been finalized and is currently is in the fabrication process. It is anticipated that the fabrication of the device will be completed by the end of August and testing will be conducted on granular base/subbase material samples collected from the field project sites with composite pavement drainage layer configurations (i.e., including both subgrade and subbase/base layers). An advantage of this device setup is that the in-situ air permeameter test device used in our field testing can be directly used on the samples in this setup to obtain direct comparisons.

Data analysis and project reports: A brief overview of the field projects is provided in the previous QPRs. The data analysis on the Michigan I-94, Iowa I-29, and Pennsylvania SR-422 projects are close to complete. The research team is currently working on finishing up project data reports for each of the projects which will feed information into the Phase I report. Analysis on Pennsylvania SR-22 project is under way.

Pavement performance testing: Seven state highway sections in Iowa have been identified for periodic performance monitoring testing, i.e., approximately once every month or two for the next three years. These are located in Moville on US20, Denison on US59, 2 sites near Plainfield on US218, Fort Dodge on US20, and 2 locations near Nevada on US30. The life of the selected pavement sections varies from 5 to 52 years, the International Roughness Index (IRI) varies from 0.8 to 3.3, and the Pavement Condition Index (PCI) varies from 25 to 99. Sections of US59 contain Asphalt overlay over the PCC layer, one section on US218 is a full depth Aphalt pavement constructed the same year as an adjacent full depth PCC pavement for comparison, all other sections are full depth PCC. Testing on these sections was initiated on May 11, 2010, which involved conducting FWD testing on the pavement surface and crack surveys. The research team will continue with periodic monitoring on these test sections.

Seasonal temperature variation monitoring: Brief information was provided in the April QPR on four project sites in Iowa with temperature sensors installed by the Iowa DOT to monitor seasonal variations in the pavement surface and foundation layers. The ISU research team is currently working with the Iowa DOT to

obtain the data that has been recorded so far and will continue to monitor the data over the course of this project. These locations are in conjunction with the pavement performance testing being conducted.

Frost heave and thaw weakening of pavement foundations: Samples of cement treated base from the Michigan I-94 project have been tested for resistance to freezing and thawing. Analysis of data is under way. A temperature array was also installed on the Michigan I-94 project to monitor subsurface temperature conditions. The temperature array monitors to a depth of six feet below the top of the subbase material and will record pavement foundation temperature conditions throughout the year. A laboratory device in accordance with ASTM D5918 is also being built to evaluate materials for frost heave and thaw susceptibility.

Main emphasis for next quarter:
Following will be the main emphasis for the next quarter:
Complete data analysis for the field projects and develop project reports for TAC review and comments.
• Review previous and current ongoing M-EPDG sensitivity studies.
• Conduct a research team online meeting for project updates (tentatively August 6/20, 2010).
• Send samples to Andrew Dawson at University of Nottingham, UK, for laboratory testing and analysis on samples collected from field project sites.
• Finish phase I report.

No.	Task Description	Completion Date Expected	% completed
1.1	Form a Technical Advisory Committee	8/31/09	100
1.2	A TAC meeting will be conducted to review current practices and to refine the proposed work plan	10/31/09	100
1.3	A comprehensive review of the literature	12/31/10	95
1.5	Document the applications and benefits of various techniques used to improve the engineering properties of pavement foundations	3/30/10	80
1.7	The Phase I draft report	9/30/10	75
2.1	Review previous and on-going M-EPDG sensitivity studies	1/31/10	10
2.2	A TAC meeting to review the results of the sensitivity analysis; workshop report will be developed	7/30/10	0
2.3	Based on field data collected during the Phase III studies, a performance evaluation using the M-EPDG, finite element methods, and ICM (climate models) will be conducted	5/30/11	0
3.1	Twelve field forensic studies will be conducted	1/31/11	20
3.2	Develop failure/performance mechanisms for each project site. The field monitoring results will be summarized	4/30/11	20
3.3	A TAC meeting will be conducted to review the results of the sensitivity analysis; workshop report will be developed	5/50/11	0
3.4	Submit a draft report to TAC summarizing the results and conclusions from the forensic studies.	6/30/11	0
4.1	A research team and TAC meeting will be conducted to review the results of the in-situ forensic investigations.	6/30/11	0
4.2	A final report	7/30/11	0

QUARTERLY BUDGET REPORT FOR
Project Title: Foundations

DATA FOR THE QUARTER ENDING June 30, 2010

BUDGET CATEGORY DESCRIPTION	AMOUNT BUDGETED	EXPENDITURES THIS PERIOD	CUMULATIVE EXPENDITURES
SALARIES/WAGES	$315,669.00	$5,360.97	$55,462.00
BENEFITS	$73,377.00	$838.82	$6,269.00
TRAVEL	$56,500.00	$0.00	$7,999.54
SUPPLIES/MATERIALS	$4,100.00	$0.00	$4,473.01
OTHER DIRECT COSTS	$105,910.00	$115.24	$44,734.52
TOTAL DIRECT COSTS	$555,556.00	$6,315.03	$118,938.07
INDIRECT COSTS (University Overhead)	$144,444.00	$1,641.93	$30,923.92
CATEGORY TOTALS	$700,000.00	$7,956.96	$149,861.99

NOTES:

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