TRANSPORTATION POOLED FUND PROGRAM
QUARTERLY PROGRESS REPORT

Lead Agency (FHWA or State DOT): ____Maryland Department of Transportation_____

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(285)*	Transportation Pooled Fund Program - Report Period: □Quarter 1 (January 1 – March 31) □Quarter 2 (April 1 – June 30) □Quarter 3 (July 1 – September 30) ■Quarter 4 (October 1 – December 31)

Project Title:
Standardizing Lightweight Deflectometer Measurements for QA and Modulus Determination in Unbound Bases and Subgrades

Name of Project Manager(s): Rodney Wynn	Phone Number: 443-572-5043	E-Mail RWynn@sha.state.md.us
Lead Agency Project ID: TPF-5(285)	Other Project ID (i.e., contract #):	Project Start Date: January/15/2014
Original Project End Date: December/31/2015	Current Project End Date: August/30/2016	Number of Extensions: 1

Project schedule status:
□ On schedule ■ On revised schedule □ Ahead of schedule □ Behind schedule

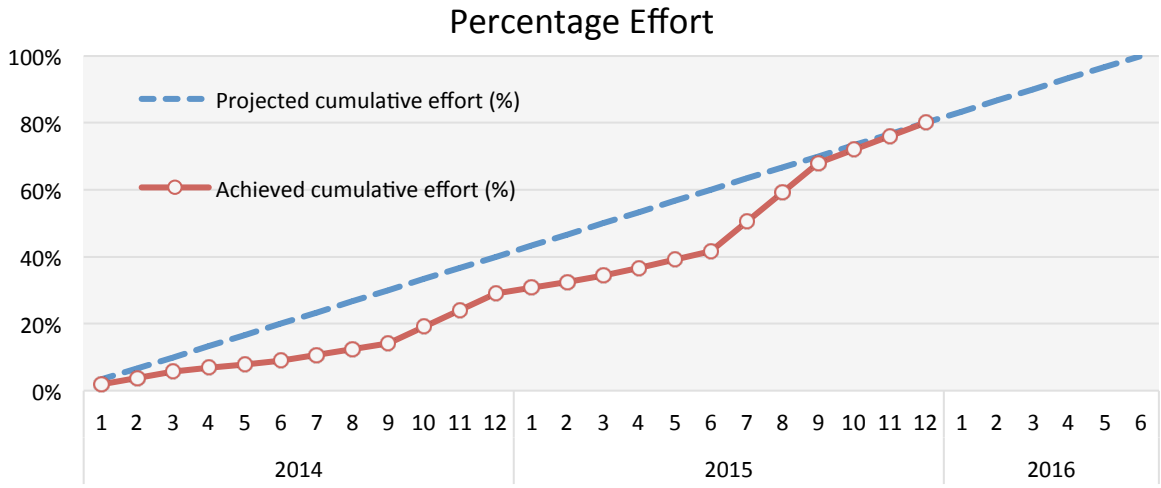
Overall Project Statistics:

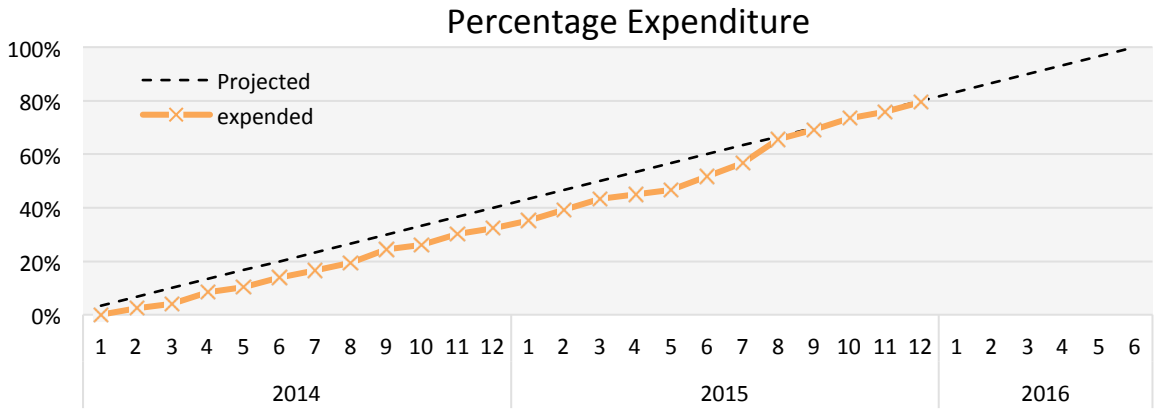
Total Project Budget	Total Cost to Date for Project	Percentage of Work Completed to Date
$371,984.00	$296,116.41	80%

Quarterly Project Statistics:

Total Project Expenses and Percentage This Quarter	Total Amount of Funds Expended This Quarter	Total Percentage of Time Used to Date
$39,113.76 10.5%	$39,113.76	79.6%

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





The progress with respect to each Task is as followed:

Task 1: Literature Review. Percent completion: 100%

The personnel continue the review of the current and upcoming literature when deemed necessary. A part of review on available and implemented studies is attached in Appendix A.

Project personnel participating in these activities: Schwartz, Khosravifar, Afsharikia.

Task 2: Equipment Evaluation. Percent completion: 100%

After the first round of LWD testing and analysis on proctor molds using Zorn LWD, Dynatest LWD, and Olson LWD, the devices were sent back to the providers to get calibrated and fixed for possible software/hardware malfunctions.

Task 3: Model Refinement/Development. Percentage completion: 81%

Several of the models refined/developed in Task 3 are in conjunction with laboratory efforts performed in Task 4.

More triaxial M_R tests have been performed according to AASHTO T-307.

In order to decrease the induced stresses in order to better represent the actual field stress states, LWD testing on mold from lower drop heights was performed on soils collected from both test pit and field projects.

Task 4: Controlled Trials. Percentage completion: 100%

Laboratory LWD tests on Proctor compacted specimens:
The process of LWD testing on Proctor molds was completed using 6 different heights on the 9 soil types used in the construction of 7 projects so far. Some LWD testing was redone on the soils from the test pits to obtain better quality data.

Laboratory resilient modulus tests:
Laboratory resilient modulus tests were performed at optimum condition as well as the test pit constructed conditions on the three soils used in the test pits.

Controlled soil box tests:
The construction of the test pits and some more in depth analysis of the results have been documented in the PhD dissertation and presentation by S. Khosravifar. Appendices A and B contain links to these documents.

Task 5: Field Validation. Percentage completion: 75%

7 of the 9 field sites were been visited during previous quarter. The 2 remaining sites were visited during last quarter. Appendix C provides a summary of the two visited projects.
All soil samples collected from 9 projects were then classified in the lab.
LWD testing from 6 different drop heights on Proctor molds was performed on the 9 soil types used in the construction of 7 projects so far.

Task 6: Draft Test Specifications. Percentage completion: 0%

No progress was made on this task during the reporting period.

Task 7: Workshop and Final Report. Percentage completion: 40%

Part of the literature review, complete documentation of test pit construction and testing, comparison of LWD devices measurements, Mr testing in the lab and correlations with test pit soil modulus are presented in the recently completed PhD dissertation by S. Khosravifar. A link to this dissertation is included as Appendix A.

UMD personnel contact information:
Charles W. Schwartz- Principal Investigator, 301-405-1962, schwartz@umd.edu
Sadaf Khosravifar- GRA, 530-531-5030, sadafkh@umd.edu
Zahra Afsharikia- GRA, 202-747-4121, nafshari@umd.edu

Anticipated work next quarter:

- Continued monitoring and documentation of the literature.
- Field validation data documentation
- Continued resilient modulus testing on the field soil samples (effect of stress states)
- Continued LWD Proctor testing with new calibration and modifications using Zorn LWD, Dynatest LWD, and Olson LWD. (moisture dependency)
- Finalizing and improving the LWD testing on Proctor mold procedure, especially on granular materials that are highly confinement dependent (utilized in finding the target modulus)
- Completing the soil drying analysis, including a parametric study on factors affecting the drying rate and validations (effect of post compaction moisture content)
- Modeling refinement to provide a comprehensive approach that combines stress, moisture dependency, and the effect of finite thickness and spatial variability in the field
- Drafting of sections of the Final Report.

Circumstance affecting project or budget. (Please 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 for this quarter.

Potential Implementation:

LWDs should be implemented more widely and this should be done using standardized testing procedures and data interpretation methods. LWDs are a tool for performance based construction quality assurance testing, which not only results in a better product, but also provides the quantitative measures critical to better understanding the connection between pavement design and long term pavement performance. As the benefits of performance based quality assurance testing become increasingly apparent, more public agencies and private consultants are expected to acquire these tools and implement standardized procedures during their use. The product of this research will allow state DOT construction specifications to be modified to include this new light weight deflectometer (LWD) option during construction quality assurance.

Appendix A

https://www.dropbox.com/s/tjcbzsp5rvc15u3/Khosravifar_thesis2015.pdf?dl=0

Appendix B

https://www.dropbox.com/s/f9bnjrhb7wztq7h/Khosravifar_Dissertation2015.pdf?dl=0

Appendix C

Field Validation Report

Project:

MD Route 404 Dualization, MD

Contract No. AW8965270

Date Visited:

10/15/2015

Address:

11419 Ridgely Rd, Ridgely, MD 21660

Contacts:

DSajedi@sha.state.md.us

Soil type:

- Subgrade: Poorly graded sand (4" of A-2-7 sand on top of A-2-6 wet soil)
- Base: Poorly graded gravel with silt and sand GP-GM

Field Testing Equipment:

- Zorn LWD (300mm radius plate)
- Dynatest LWD (300mm radius plate)
- Olson LWD (300mm radius plate)
- Nuclear Density Gauge (NDG)
- Kestrel 4300 Construction Weather Tracker
- Ohaus Moisture Analyzer
- Volumetric Moisture Content (VMC) sensor

Field Data Captured:

- 10 stations LWD testing on top of the freshly compacted subgrade and base; drops from half height and full height
- 10 stations NDG testing on the freshly compacted subgrade (on the surface and 6" depth) and base
- Recorded weather condition and soil temperature during testing
- 10 stations subgrade (from top few inches and bottom soil) and base sampling for gravimetric moisture content oven testing in the lab
- 2 samples were tested for the MC at the time of compaction with Ohaus Moisture Analyzer in the field

Lab Testing:

- Gravimetric moisture content oven testing
- Gradation (AASHTO T27-11 designation)
- Atterberg limits (AASHTO T89-13, T90-00)
- Specific Gravity (AASHTO T85-10, T84-10, ASTM D854-14 designations)
- Standard Proctor Testing (AASHTO T99-01 designation) (in progress)
- LWD drops from 1,2,3,4,5 inches and half height on compacted proctor molds (in progress)
- Resilient Modulus testing (in progress)

Figure 1- MD route 404 Subgrade LWD and NDG testing

Figure 2- MD route 404 LWD testing on compacted base

Project:

SR 23 Project, South Jacksonville, FL

SR 21 (BLANDING BLVD) TO: DUVAL County Line

Date Visited:

10/20/2015

Address:

Branan Field Rd, Orange Park, FL 32065

Contacts:

david.horhota@dot.state.fl.us

Jose.Hernando@dot.state.fl.us

Willie.Henderson@dot.state.fl.us

Soil type:

- Stabilized Subgrade: Limerock and Poorly graded sand (A-2-7)
- Base: Limerock, Poorly graded gravel with sand (A-3)

Field Testing Equipment:

- Zorn LWD (300mm radius plate)
- Dynatest LWD (300mm radius plate)
- Nuclear Density Gauge (NDG)
- Kestrel 4300 Construction Weather Tracker

Field Data Captured:

- 10 stations LWD and NDG testing on top of the freshly compacted subgrade. LWD drops from half height and full height

- 2 rounds (1:30 hour apart), 10 stations LWD and NDG testing on the freshly compacted Base. LWD drops from half height and full height
- Recorded weather condition during testing
- All 10 stations subgrade and base sampling for gravimetric moisture content oven testing in the lab (done at the District 2 Materials Office, 1109 South Marion Avenue, Lake City, FL 32025)

Lab Testing:

- Gradation (AASHTO T27-11 designation)
- Atterberg limits (AASHTO T89-13, T90-00)
- Specific Gravity (AASHTO T85-10, T84-10, ASTM D854-14 designations)
- Standard Proctor Testing (AASHTO T99-01 designation) (in progress)
- LWD drops from 1,2,3,4,5 inches and half height on compacted proctor molds at proposed target moisture contents (in progress)
- Resilient modulus testing (in progress)

Notes:

Since we had to fly to Jacksonville, we only used the Zorn and Dynatest LWD available there.

Figure 3- SR 23 LWD testing on compacted Base