Quarterly Progress Report

TPF-5(039)	Falling Weight Deflectometer (FWD) Calibration Center and Operational Improvements

Principal Investigator:	Agency:
Dr. Lynne H. Irwin (607) 255-8033 LHI1@cornell.edu	Cornell Local Roads Program Cornell University 416 Riley-Robb Hall Ithaca, NY 14853

Reporting Period:	April 1, 2005 through June 30, 2005

Project Status: (Tasks 1-5)		
	Work completed through end of period:	23.5%
	Project funds expended:	22.9%
	Expected completion date:	September 6, 2006

Project summary

The objective of this project is to update the equipment and procedures for calibration of Falling Weight Deflectometers (a device for measuring pavement deflection response due to a pulse load), incorporating selected technological developments that have occurred since the current calibration protocol was released in March 1994. The details of the project are described in FHWA's Statement of Work which is posted at the TPF-5(039) Web site

Activity during the reporting period

Among the activities during the reporting period were the following.

- Held the second meeting of the Technical Advisory Committee on April 27-28 in Albany, NY. The minutes of the meeting are posted at TAC Minutes.
- Reviewed and summarized the technical specifications for the four major brands of FWDs.
- Conducted telephone interviews with six out of seven calibration center operators.
- Established a subcontract agreement with Applied Research Associates. Inc.
- Completed a white paper on the use of accelerometers in FWD calibrations with the assistance of ARA.
- Constructed a concrete test pad in our laboratory for performing FWD calibrations in accordance with the March 1994 SHRP/FHWA FWD Calibration Protocol. After a 28-day concrete cure, the test pad deflections were found to be exactly as desired.

- Calibrated FWD load and deflection sensors in our laboratory using the SHRP Protocol and the DOS-based FWDREFCL computer program. We used the Cornell-owned Dynatest FWD in this work.
- Surveyed all suitable products for data acquisition and purchased a Keithley KUSB-3108 board.
- Hired a computer programmer and began the conversion of FWDREFCL from DOS QuickBasic to Windows VisualBasic6.
- Continued a dialog with the FWD manufacturers seeking their input for improvements in the protocol and discussing specific ideas for changes.

Problems encountered during the reporting period

During the quarter we reviewed the specifications of all four major brands of falling weight deflectometers. The objective was to identify modifications to the calibration protocol that might be needed to better accommodate all types of FWDs. The results were not definitive. Our subsequent actions will be discussed below under Task 1b.

Work completed by task

The six tasks referred to below are described in detail in the Statement of Work. Our strategy is to work simultaneously on Tasks 2 and 3. We feel that both the hardware upgrades and the software upgrades interact, and thus it is more efficient to work on the two tasks together.

Task 1. Communication, Coordination and Reference Resources

Task 1a is complete. All protocols, software, and drawings of the currently used equipment that are available are in hand.

Task 1b will continue throughout the project. This task provides for a dialog with the FWD manufacturers and the calibration center operators. We feel this dialog should continue for the duration of the project.

The specifications for all four brands of FWDs have been reviewed. We prepared a brief synopsis, noting the similarities and differences in the four brands. This exercise did not provide much insight concerning needed modifications of the calibration procedure. We found that we needed more specific details than we could get from the review of manufacturers' specifications.

To overcome this problem we decided to conduct a series of telephone interviews with the Calibration Center Operators, and with designated representatives of the four manufacturers. Two series of questions were formulated, one for each group. As the reporting period ended we had completed the interviews with six out of seven of the calibration centers. The interviews so far have provided a good response and a number of suggestions to be considered. We will finish the interviews, including the manufacturers, early in the next quarter. A summary report will be submitted as soon as a complete set of responses has been gathered.

Task 2. Modify Calibration Process

In order to compare any changed processes and procedures to the SHRP/FHWA FWD Calibration Protocol, it was necessary to build a complete SHRP calibration center. This work was finished during the reporting period.

Task 2a is continuing. A goal for streamlining the calibration procedure was established at the April meeting of the Technical Advisory Committee (TAC). We will try to expedite the procedure so it can be completed within three hours.

The first step for evaluation of modified calibration test procedures is to establish a data base of the results from the current procedure. This is needed to demonstrate that the streamlined calibration procedure meets or exceeds the accuracy and repeatability achieved with the current calibration procedure. As the quarter ended we had a working set of equipment and software for use with the SHRP/FHWA protocol. We began using our Dynatest FWD to create a data base of test results establishing their accuracy and repeatability.

Task 2b is continuing. It will be easy to add a sensor that can be used as an automated triggering device. However, first we are trying to use the buffering capabilities of the Keithley KUSB-3108 DAQ board to create a software trigger. This should be less costly. This work will continue during the next quarter.

Task 2c is continuing. Our initial efforts under this task have focused on the use of an accelerometer in lieu of the LVDT for measuring the peak deflections. If this initiative is successful it will eliminate the beam and avoid the need to detect beam movement. We have completed a white paper on the use of accelerometers, and during the coming period we will evaluate several different accelerometers that are recommended in the paper. Dick Stubstad and Dan Chitty from Applied Research Associates assisted with the paper. This work will continue during the next quarter.

Task 3. Hardware and Software Upgrades and/or Development

Task 3a is continuing. We selected and purchased a Keithley KUSB-3108 data acquisition board. We gave careful consideration to the selection of the programming language to be used with the board. We selected VisualBasic6 for Windows because we felt it offered the best opportunity for continued support and upgrade by the widest variety of agencies. It also is well-adapted to formatting an output report as required under Task 3a. In June a contract programmer was hired. He began converting the DOS FWDREFCL computer program to VB6. This work will be completed early in the next quarter.

No effort was made on Task 3b during this reporting period. Effort on this task is not scheduled to begin until late summer 2005.

Task 4. Calibration System Testing, Installation and Operator Materials/Training

No effort was made on Task 4a, 4b, or 4c during this reporting period. Effort on these tasks is not scheduled to begin until late fall 2005.

Task 5. Presentation and Reporting

We provided staff support for a meeting of the Technical Advisory Committee that was hosted by the New York State Department of Transportation at their headquarters facility in Albany, New York. Meeting was held on April 27-28. The minutes of the meeting are posted at TAC Minutes.

Task 6. Miscellaneous Support for TPF-5(039)

This task is not included in the current contract. Effort on this task is not anticipated before fall 2006. It will require separate task orders.

Work planned during the coming quarter

Under Task 1 we will continue to seek input from the FWD manufacturer and calibration center operators concerning needed calibration protocol modifications. We will prepare a brief synopsis of our findings based mainly on the results of a series of telephone interviews.

Under Task 2 we will complete the development of a data base of calibration test results. We will purchase and evaluate several different MEMS accelerometers for use in deflection sensor calibration, substituting for the concrete block, beam and LVDT in the current procedure. If it appears that accelerometers can be used, then we will build an accelerometer calibrator.

We will continue the software development efforts to determine if the KUSB-3108 board can be used as an alternative to providing a hardware triggering device.

We will design several new sensor holders that can be used to conduct reference and relative calibration on all geophones simultaneously. We will establish their accuracy and repeatability.

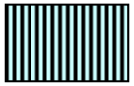
Under Task 3 we will continue with the conversion of the DOS program FWDREFCL to the VisualBasic6 language. First we will convert the demo version of the program, then we will introduce calls to the Keithley USB-3108 DAQ board. We will compare the results of these calibrations to the data base of results using the DOS version of FWDREFCL.

Task 4 – No activities planned.

Task 5 – No activities planned.

Task 6 – Not included in the current contract.

Table 1. Work Schedule and Completed Work

WORK COMPLETED 

Year	2004			2005											
Month	October	November	December	January	February	March	April	May	June	July	August	September	October	November	December
Task															
1 Communication, Coordination and Reference Resources															
2 Modify Calibration Processes						TASK 2									
3 Hardware and Software Upgrades										TASK 3					
4 Testing, Installation, and Training													TASK 4		
5 Presentation and Reporting															
6 Miscellaneous Support															

Year	2006									2007	2008	2009	Percent of Task Completed
Month	January	February	March	April	May	June	July	August	September	FY	FY	FY	
Task													
1 Communication, Coordination and Reference Resources													80
2 Modify Calibration Processes													45
3 Hardware and Software Upgrades													40
4 Testing, Installation, and Training	TASK 4												0
5 Presentation and Reporting		TASK 5			Draft Report	TASK 5			Final Report				0
6 Miscellaneous Support (not in this contract)										TASK 6			Not in contract