Meeting Minutes of the First Meeting of National Pooled-Fund Study TPF-5(039) Falling Weight Deflectometer (FWD) Calibration Centers and Operational Improvements

May 21-22, 2003
College Station, TX

Participants/Attendees:

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Introductions and Initial Discussions

Participants were asked what their expectations and hopes were for the outcome of the meeting and the pooled-fund study overall. Responses:

- A framework for Phase I Statement of Work
- Upgrade the SHRP FWD calibration hardware and software to 21st Century technology
- Improve the ability to process the FWD data
- Improve the current LTPP/SHRP FWD calibration protocols
- Update the software and protocols to expedite FWD calibration
- Ensure that the current calibration sites remain in operation
- Refine the FWD calibration process, improve repeatability among FWD units and reduce variability in FWD measurement while reducing time of process in calibration
- Implement a portable verification device for use in the field
- Establish performance-based specifications for states to use to purchase equipment. There is some concern about having to calibrate other manufacturers equipment,

given that the TX procedure is made for Dynatest equipment. Also, proprietary purchases are becoming more difficult.

Funding and Participation

Currently there are 13 states participating with total funding commitments of $445k. LTPP will continue to provide support to the existing four FWD calibration centers until the end of the program in 2009. However, LTPP does not have the resources to fund the improvements proposed in this study.

The scope of work done in Phase I and Phase II may be modified from that outlined in the "Problem Statement", depending on the outcome of the meeting. The participating States have the choice to change the way they designate their funds between the two phases. In the pooled-fund study, unused money from one fiscal year rolls to the next.

The entire group of Participating States identified a need for a mechanism to financially support the future needs of the FWD calibration centers. They strongly advise that this be addressed in Phase I of the study.

How can long-term funding of the calibration centers be accomplished? There are laws in place that make it difficult for state dot's to accept payment for services, and apply those funds directly to the calibration center. The group requests that FHWA look into how this can be accomplished. If calibration fees could be fed into a pool, then the host states could use this money to pay for operational costs, hardware/software upgrades and technical support. Perhaps non-host states that use the calibration center services could provide annual contributions to the fund? Perhaps corporate sponsors should be considered, i.e. FWD manufacturers?

Pooled-fund monies using SP&R funds are meant for research, and calibration center roles are in part operational. Therefore the Pooled-Fund Study itself may not be appropriate to provide this long-term support. Technology transfer funds could be used for training support, but probably not for hardware and software maintenance. Perhaps more partnerships could be established between state DOTs and universities, as is the case with TX DOT and TAMU at TTI.

Direct costs are estimated at $150k to provide hardware and software improvements, alone, for the existing centers. Implementation of these improvements at the existing centers may be accomplished with $250-300k, but that will probably not be enough to outfit the additional centers.

The AASHTO Subcommittee on Materials adopted a resolution on FWD calibration centers on August 3, 2001 [attachment 1]. This resolution calls for similar actions to those proposed in this study.

Visit to TTI for demonstration of SHRP and TX calibration setups

The Current SHRP –LTTP FWD Calibration Procedure Presentation
This presentation can be viewed at www.ltpp.org/curr_cal_procedure.ppt

Discussion:
The SHRP FWD calibration process has adapted over the years to accommodate differences between FWD manufacturers. As new manufacturers emerge, more modifications may need to be made and strong cooperation between calibration centers and manufacturers will be required.

The reference load cell is calibrated at Cornell. To calibrate one load cell it takes two to three days if it works well and five to six calibrations according to protocol in order to get the calibration. Normally there isn't a need to do physical adjustments.
Currently, there is no independent way to measure beam movement.

Can extra (calibrated) geophones be carried with the FWD to replace one or more geophones with suspect output? Carrying spare geophones can be very costly, however it can be done, and once the calibration is performed on the "swapped" geophone, the new gain factors can be applied to the data. However the data from the bad geophone will be lost. It is suggested that often the problem may be with mechanical situations, however, it could also be a valid response in the pavement. There is a need for a checklist for reference to determine whether the problem lies with the FWD or the pavement. Guidelines may be established to handle this situation, as a product of the study. The question arises if a diagnostic program could be written to point out whether a bad ground is suspect. These types of checks should be provided with the software from the manufacturer.

Presentation on the TX DOT FWD Calibration Procedure

Improving Repeatability - Impact of Uncertainty in Measured Deflection on Typical Thin Pavement

Visit www.ce.utep.edu/chmr for copies of the slides or reports. If there is a problem accessing that site, please send a request by e-mail to chmr@utep.edu.

Reproducibility of Fleet Requires Improvement. Some important points:
Maintenance is vital.

- Clean electrical connections
- Lubricate the swivel on the load cell monthly
- Bumpers were found to vary in stiffness as received from the manufacturer. This was found to have an impact on measurements. Match the stiffness of bumpers and mount them with a torque wrench.
- Annually change the pad and neoprene beneath the load plate for consistent load application

- Annually change the springs and neoprene guides in the sensor holders
- Instrumentation of the FWD frame revealed problems associated with vibration of the trailer. The vibration moves the raise/lower bar so that sensor holder is not truly isolated from the frame. Efforts should be made to minimize this vibration.

Discussion:
Poor grounding can affect geophone readings, as well as other factors like trailer batteries. Perhaps it may be feasible to develop a diagnostic program to check everything. The FWD and manufacturers should provide this tool with the operational software. Dynatest provides a drift plot.

A major advantage of the TX calibration procedure, as compared to the SHRP procedure is that sensors are calibrated without removing them from their holders. It is suggested that the TX procedure would be great as a portable verification procedure. It is also suggested that verification may be accomplished within the FWD operational software.

Both the TX and SHRP FWD calibration procedures are affected by environment.

Operational Improvements to the SHRP-LTTP Calibration Procedure Presentation

Some important points:

1988-2003
-Initial efforts began in 1988 in Florida
-Built 4 centers for total of $60,000
The "old" way is not necessarily the "best" way.
Why upgrade?
-Hardware and software are ~12 years old
-DAS-16 board is an ISA bus design, while the computer industry standard today is the PCI bus.
-Some procedures are slow and cumbersome
-Some procedures not well adapted to all FWD manuafacturers
-Need to take advantage of and implement much of what we have learned over the past decade.
New Techniques Available
-16-bit PCI boards
-Visual BASIC compatible drivers
-Programming is easier
-Accelerometers have become inexpensive
-Expedite the tedious tasks
The MINIMUM that is needed
-Select new data acquisition boards
-Update software to Windows compatible
-Utilize PDDX file format for data transfer
-across all brands of FWDs
-software will work with all FWDs

Desirable Additional changes

-Develop holder to do reference calibration of all sensors simultaneously.
-Add accelerometer to detect release of the FWD mass
-Add calibrated accelerometer to measure beam movement

Possible Additional Changes

-Add direct data transfer from FWD computer to FWDREFCL
    -Floppy disk (PDDX file)
    -universal bus link
-Add database to allow easy comparison with past calibrations

Other Possibilities

-see if we can "eliminate" doing the relative calibration as a separate process during annual calibrations
-Would utilize the platter-type holder
-May require doing a few more than the current 20 drops for reference calibration
-Continue to use relative calibration for field check, or use the TX approach

Recommendations

1. Solicit input/suggestions from all existing calibration centers
2. Investigate doing simultaneous reference calibrations of all deflection sensors
3. Implement PCI compatible DAQ card.
4. Investigate modifying procedure to combine reference and relative calibration into one protocol.
5. Add sensors to detect release of mass and beam movement.
6. Add direct data transfer capability from FWD computer
7. Update software to have Windows compatibility
8. Select field calibration Verification. Procedure
9. Develop database of past FWD calibration results
    -May require setting up a clearinghouse to maintain and update the database periodically

<u>Discussion:</u>

The group tended to agree with most of the recommendations, and agreed that the study should remain focused on long-term support of FWD calibration centers. This support can allow calibration centers to become self-sufficient in maintaining software and hardware in the future. To aid in this process a system of coordination should be established between calibration centers and FWD manufacturers to maintain compatibility with FWD units and the calibration process. For example, using binary vs. text files.

There seems to be some confusion among calibration center customers about whether the SHRP calibration process is a certification, which it is not. The calibration centers can verify that the FWD unit passed the SHRP calibration procedures, but they cannot certify the FWD operators.

Another consideration for calibration center improvements is the current weight limitation at calibration centers. Future center improvements may include accommodations for heavyweight deflectometers (HWDs).

The question arises of how many calibration centers is enough? Since there is a substantial amount of training involved with staffing calibration centers, the optimization of number of centers and geography is prudent. There are tentative plans to open a center at UC Davis in CA. There are also centers in KS and IN that do not service outside customers. If those three centers were included in the study, and possibly another in the southeastern US, then service area would be well covered geographically.

Brainstorming Session for Calibration Center Needs and Improvements
See the attachment 2 for the sorted brainstorming items.

On the subject of Quality Assurance:
QA reviews should be separated between the center operator and the center facility itself.

- If the calibration procedure is changed, then the review process will need to be changed.
- Calibration center operators spend a lot of time troubleshooting equipment during calibration visit even though the equipment is supposed to be in good working order upon arrival. Maintenance is the responsibility of the owner not of the calibration center.
- Training should be made available to FWD operators and calibration centers regarding maintenance practices.

Marketing
An effort to demonstrate the importance of FWD calibration should be made to the state DOT's. A cost benefit ratio would be the most effective means of accomplishing this. FWD data is useful for both design and research. Results of this meeting should be discussed at the next FWD Users Group Meeting in KS in October 2003.

The participants would like to be in a good enough position at the end of Phase I to attract people to join Phase II. Some states specifically earmarked money for phase I and other money for Phase II. MT wants to see what happens with Phase I before they commit to Phase II. Additional states should be approached with progress made at this meeting to invite further participation. Anyone can check the Transportation Pooled Fund Program (TPF) Website at www.pooledfund.org to check the status of the study and join.

Improvements and other study actions were prioritized by phase, category and level-of-effort. Most actions concerning hardware/software/process improvements are desired for Phase I, including the investigation of long-term funding mechanisms. Phase II actions are primarily focused on implementation, expansion of the number of centers and resulting products such as guidelines and training.

Meeting minutes and brainstorming results will be distributed to all participants for comment and posted on the pooled-fund website. The results of this meeting will be used

to establish a statement of work for Phase I of this study. Hopefully the results of this meeting will generate further interest in participation from other states.

Adjourn