Calibration and Specifications for the Falling Weight Deflectometer and Heavy Weight Deflectometer

Prepared for the

ALACPA Conference

October 2009
Sao Paulo, Brazil

By
Frank B. Holt
Sr. Vice President
Dynatest International A/S

With kind assistance from
Dr. Gonzalo Rada
Fugro USA

Introduction to Seminar: Technical Content

5. Garbage in, garbage out (6)

- Should we collect friction or deflection data with equipment not calibrated and make decisions based on those data? There is no point; waste of money!
- Seminar includes sessions on calibration of friction and deflection testing equipment

Outline

- Terminology
- Equipment
- Standards
- Other references

Terms To Be Familiar With

- ***reference calibration*** —term used to describe the calibration of either the FWD load cell or deflection sensors against a separate reference measuring system. For load cell calibration, the reference system is a custom-made reference load cell; and for deflection sensors, it is a precision accelerometer.
- Done at the factory and / or at a Calibration Center

Terms To Be Familiar With
(cont'd)

- ***relative calibration*** —term used to describe a calibration procedure in which the deflection sensors are calibrated relative to one another. No outside reference system is used; the sensors are compared to each other.
- It is a quick means to periodically verify that the sensors are functioning properly and consistently

Why are these two terms critical?

- Relative calibration is done at least monthly.
- Reference calibration is done annually at a calibration center, or by a certified technician on location.
- If these are not done how do you know if the data is good?
- Inaccurate data will lead to inaccurate results and designs

Deflectometer Equipment

Some Different Deflectometers

Light Weight Deflectometer (LWD)

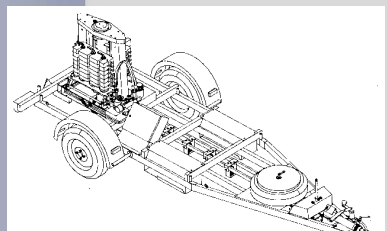
- While only used on unbound materials these devices also require calibration annually.

Deflection Measurement

- The load cell and sensors are the critical component to collect accurate data

What is an HWD / FWD?

- *Comprised of a tow vehicle and trailer*
- *Designed to impart a dynamic load to a pavement structure*
- *Measures deflection of the pavement surface*
- *Simulates a moving wheel load.*



What is it Used For?

- *Structural capacity/remaining life estimates*
- *Load transfer efficiency between PCC pavement joints*
- *Void detection in PCC pavements*
- *Network level pavement management*
- *Project level pavement investigations*
- *Many research applications.*

Standards

HWD/FWD Calibration

"Think of FWD deflections as shots at a target"

Uncalibrated Sensors
May or may not fall within a 2%
May or may not be biased

After Reference Calibration
Randomly scattered closer to target

After Relative Calibration
Very close to intended target

Important Standards

- **Owners Manual for your FWD/HWD**
  - Provides the manufacturer's recommendation on maintenance and calibration
- **ASTM D4694 - Standard Test Method for Deflections with a Falling-Weight-Type Impulse Load Device**
- **ASTM D4695 - Standard Guide for General Pavement Deflection Measurements**

Important Standards

- FAA AC 150/5370-11A - USE OF NONDESTRUCTIVE TESTING IN THE EVALUATION OF AIRPORT PAVEMENTS
  - Section 11 states: "…the NDT equipment sensors should provide accurate and repeatable deflection measurements at each sensor location."

FAA AC 150/5370-11A - USE OF NONDESTRUCTIVE TESTING IN THE EVALUATION OF AIRPORT PAVEMENTS

- This AC also provides excellent guidance to users for testing procedures on both Asphalt and Portland cement Concrete pavements

AASHTO R32-09

- The Standard Recommended Practice for Calibrating the Load Cell and Deflection Sensors for a Falling Weight Deflectometer
- The American Association of State Highway and Transportation Officials (AASHTO) developed R32 in January of 2009

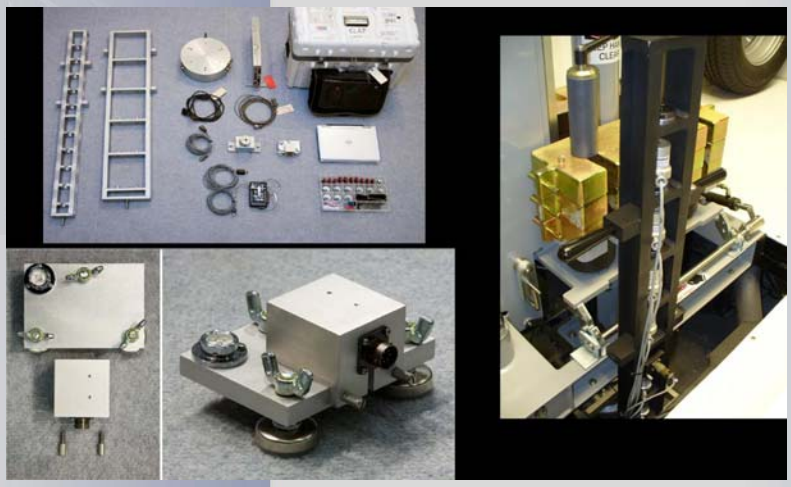
Standard requirements

- The equipment is highly specialized and will be available for a source to be determined
- The site and operators will be trained and certified prior to any calibration being performed.

R32 Overview

- Defines terminology
- Defines the Method
- Defines the Apparatus to be used
- Defines the setup of the FWD/HWD for the calibration
- Defines the setup of the Reference Load cell and the deflection sensors
- Defines the annual and monthly procedures
- Defines the Report that should be provided after calibration
- Defines the Precision and Bias of the procedure

Calibration Equipment



Apparatus

- The calibration facility is defined as indoor space with controlled temperature and a level floor large enough for vehicle and trailer
- The test pad may either be constructed or an existing slab which meets defined criteria for size and deflections

Test Pad

- Portland Cement Concrete
- Typically 4 by 5 meters and crack free although an existing slab may have hairline cracks no wider than 1.5 mm
- Slab should be isolated from the surrounding floor so transient vibrations are not transmitted into the pad
- Slab deflection of 300 microns with a 70 kN load
- Minimum slab thickness of 125 mm on 200 mm open graded crushed materials
- Subgrade modulus less than 80 MPa
- Bedrock deeper than 7 to 9 meters

FWD/HWD setup

- FWD/HWD shall be properly maintained and working
- Shall be attached to the tow vehicle if a trailer
- Program a minimum of 3 load levels with a maximum of 80 kN +- 10%
- 18 to 30 drops in the sequence with the same sequence being used for the load cell calibration and the deflection sensor calibration

Calibrating a built in FWD

Results

- Deflections Sensors are acceptable if the slope for an individual sensor is not more than 0.0020
- The trial is acceptable if all sensors are not more than 0.0020
- The calibration software will determine the Reference Gain Factor for the sensor and the RMS difference for all sensors
- If RMS is >0.003 it indicates some sensors may not be repeatable

Acceptance

- The Final Gain factors are compared to the previous calibration
- The difference shall not be higher or lower than 1% for each sensor and the load cell.
- A change over a number of years greater than 0.1% per year is unacceptable

Calibration Certificate

- Upon successful completion of the process a Calibration Certificate will be issued for the load cell and deflection sensors on the machine.

Summary

- The new AASHTO standard will be the foundation of calibration procedures both in the US and the European Road communities.
- Some equipment manufacturer's can now offer Calibrations of the equipment on site thanks to the new procedures and equipment developed by Dr. Irwin and AASHTO

Summary Cont'd

- Ask your engineering consultants to see the calibration records for their equipment as part of your contract requirements. This will help ensure that your data will be accurate
- Ask to see their testing plan and pattern to ensure it will fully meet your needs and show you that they know what they are doing.

Web Site Assistance

- www.faa.gov/documentLibrary/media/advisory_circular/150-5370-11A/150_5370_11a.pdf
- www.astm.org (Available in Spanish)
- www.transportation.org/ (AASHTO web site)

Gracias por su atención

Thanks also to Dr. Gonzalo Rada for helping make this presentation

Questions?