

**Standard Practice for
Calibrating the Reference Load Cell Used for Reference
Calibrations for Falling Weight Deflectometer**

AASHTO Designation PP8-94^{1,2}

1. Scope

1.1 The reference load cell is a precision instrument, capable of measuring loads within ± 0.3 percent. Such a high degree of precision can be attained, however, only if this calibration procedure is followed exactly.

1.2 It is essential that the reference load cell be calibrated using a universal testing machine that is properly maintained and accurately calibrated.

1.3 The reference load cell and its cable, and the associated signal conditioner, data acquisition board and computer are considered a **system** of instruments, which are to be calibrated together and used together.

1.4 *This practice may involve hazardous materials, operations, and equipment. It does not purport to address all of the safety problems associated with its use. It is the responsibility of whomever uses this practice to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 AASHTO Standards

PP7 Calibrating the Load Cell and Deflection
Sensors for A Falling Weight Deflectometer

2.2 ASTM Standards

E74 Calibration of Force-Measuring Instruments
for Verifying the Force Indication of Testing
Machines

3. Summary of Method

3.1 The reference load cell system is calibrated against a recently calibrated universal testing machine.

3.2 The reference load cell system is conditioned in the testing machine by loading it three times to 89 kN (20000 lbs.).

3.3 Loads are applied at a rate of 4.4 kN (1000 lbs) per minute and read from both the load cell system and the testing machine.

3.4 Develop a regression equation for a fifth degree polynomial. Check this equation to ensure all calculated coefficients are significant. If they are not, then repeat the regression using a fourth degree polynomial and so forth.

3.5 The regression coefficients are entered into the data acquisition software used for the reference load cell system.

Note 1 - A data acquisition software which has been successfully used is the program FWDREFCL which is available from the Long-Term Pavement Performance (LTPP) Division at the Federal Highway Administration, Turner-Fairbank Highway Research Center, McLean, Virginia.

4. Significance and Use

4.1 In order to be confident in the calibration factors derived in the Falling Weight Deflectometer (FWD) load cell calibration, the reference load cell must be calibrated against known loads.

¹ This standard is based on SHRP Product 5004.

² Approved in October 1994, this provisional standard was first published in March 1995. Reconfirmed January 2000.

4.2 Although the loads recorded during FWD load cell calibration are dynamic in nature, a static method of calibrating the reference load cell is utilized here.

5. Description of Terms Specific to This Standard

5.1 Reference load cell is a custom built calibration device with a diameter of 300 mm (11.81 in.) and a loading capacity of 178 kN (40000 lbs). It is used to calibrate the in-place load cells on the FWD.

5.2 Reference load cell system is comprised of the reference load cell, its cable, the associated signal conditioner, data acquisition board and computer. This system must be maintained for use in the FWD load cell and reference deflection sensor calibrations.

6. Apparatus

6.1 Universal testing machine. A static testing machine, hydraulic or screw-powered, with a load capacity of 534 kN (120000 lbs) or more should be used for the reference load cell calibration. Although the reference load cell will only be calibrated to a capacity of 89 kN (20000 lbs), the higher capacity of the testing machine assures that the test frame will be adequately rigid. The testing machine shall have several load ranges, among them a 0 - 89 kN (0-20000 lb) range (slightly higher ranges, such as 0 - 106.8 kN (0 - 24000 lb), etc., are acceptable). Care must be taken to avoid overloading the reference load cell during its calibration.

Note 2 - Do not use a servo-controlled, closed-loop testing system such as an MTS machine for this purpose. In general such equipment does not provide the high degree of accuracy that is required for this calibration.

6.2 Bearing blocks - special wood/aluminum bearing blocks.

6.3 Measurements Group, Inc. Model 2310 Signal Conditioner, or equal. This shall be the same signal conditioner that is used in the reference calibration procedure as referred to in PP7.

6.4 Keithley-MetraByte DAS-16G data acquisition board, or equal, installed in the same computer that is used for reference calibration, as referred to in PP7.

6.5 Push-button trigger for activating the data acquisition system.

7. Preparation of Apparatus

7.1 The universal testing machine shall be calibrated according to ASTM procedure E-74 within twelve months prior to conducting this procedure. The device(s) used to calibrate the universal testing machine shall be certified to be traceable to the National Institute of Standards and Technology (NIST) calibration(s). The certificate of calibration provided for the universal testing machine shall be used to develop an adjustment algorithm which will correct the indicated load on the universal testing machine to the NIST load.

7.2 The MetraByte board shall be calibrated according to the procedure described in the manufacturer's instruction manual. Its accuracy shall be verified using a reference voltage source such as a 1.350 volt mercury cell (e.g., camera battery in new condition).

7.3 The 2310 signal conditioner amplifier shall be balanced according to the procedure described in the manufacturer's instruction manual. With the signal input terminals shorted together, at a gain of 100, the ac noise on the ± 10 volt output shall be 1 millivolt or less.

7.4 Inspect the reference load cell carefully before calibration. Verify that the cable and the Amphenol connectors are making proper contact in their sockets (e.g., fitting and locking tightly).

7.4.1 Make a continuity check to verify that there are no breaks in the wires. Verify that the Allen screws on the load cell are tight.

Note 3 - The six Allen screws on the top and bottom of the load cell were torqued to 11.3 N-m (100 lb-in) and set with Loctite during assembly. These screws shall not be loosened unless it is absolutely necessary. If any of the screws are loosened, they shall be removed one at a time and their threads cleaned. Loctite shall be reapplied to their threads, and they shall be torqued to precisely 11.3 N-m, (100 lb-in).

7.5 Verify that the three steel pads on the bottom of the reference load cell are in good condition.

7.6 Verify that one of the wood/aluminum bearing blocks has a ribbed rubber pad cemented to it. If the edges of the rubber pad are loose, use rubber cement to reattach it.