FLORIDA DEPARTMENT OF TRANSPORTATION
State Materials Office
5007 NE 39th Avenue
Gainesville, Florida 32609

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Florida Test Method

for

PAVEMENT DEFLECTION MEASUREMENTS WITH A FALLING WEIGHT TYPE IMPULSE LOAD DEVICE

Designation: FM 5-606

1. SCOPE

1.1 This test method describes the measurement of vertical deflection response of the surface to an impulse load applied to the pavement surface. Vertical deflections are measured on the load axis and at points spaced radially outward from the load axis.

1.2 This test method contains two parts:

PART A – Deflection measurements performed on Flexible Asphalt Concrete (AC) Pavements.
PART B – Deflection measurements performed on Rigid Portland Cement Concrete (PCC) Pavements.

1.3 This test method does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this test method to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

2. REFERENCED DOCUMENTS

2.1 ASTM D4694: Standard Test Method for Deflections with a Falling-Weight-Type Impulse Load Device.

2.2 ASTM D4695: Standard Guide for General Pavement Deflection Measurements.

2.3 AASHTO T256: Standard Method of Test for Pavement Deflection Measurements.

2.4 AASHTO R32: Standard Practice for Calibrating the Load Cell and Deflection Sensors for a Falling Weight Deflectometer.

2.5 AASHTO R33: Standard Practice for Calibrating the Reference Load Cell Used for Reference Calibrations for a Falling Weight Deflectometer.

2.6 Strategic Highway Research Program: Long Term Pavement Performance Program Manual for Falling Weight Deflectometer Measurements, Version 4.1, December 2006.

2.7 Dynatest FWD Operation Instructions.

2.8 Bouzid, C., Salil, G. and Abdenour Nazef, “Assessing the Precision of Falling Weight Deflectometers for Field measurements”. Research Report FL/DOT/SMO/03-468, Nov 2003.

3. SIGNIFICANCE AND USE

3.1 This test method covers the determination of pavement surface deflections as a result of the application of an impulse load to the pavement surface. The resulting deflections are measured at the center of the applied load and at various distances away from the load. Deflections may be either correlated directly to pavement performance or used to determine the *in-situ* material characteristics of the pavement layers or joint efficiency. Some uses of the data include structural evaluation of load carrying capacity, load transfer efficiency and void analysis of rigid pavements, and determination of overlay thickness requirements for highway and airfield pavements.

4. APPARATUS

4.1 The apparatus used in this practice shall be a Falling Weight Deflectometer (FWD).

4.2 FWD is a non-destructive testing device used to measure surface deflections of in-service pavements (Figure 1). It consists of a 12 inch (300mm) diameter loading plate, a load cell, deflection sensors, and a control unit. The loading device generates an impulse load on the pavement surface by dropping a mass from different heights onto a rubber type spring buffer system.

Figure 1. Picture of a Falling Weight Deflectometer (FWD) testing device.

4.3 The FWD device has series of sensors at certain set distances that measure vertical pavement deformations when subjected to a given load. Figures 2 and 3 show sensor configuration used for testing on flexible and rigid pavements, respectively.

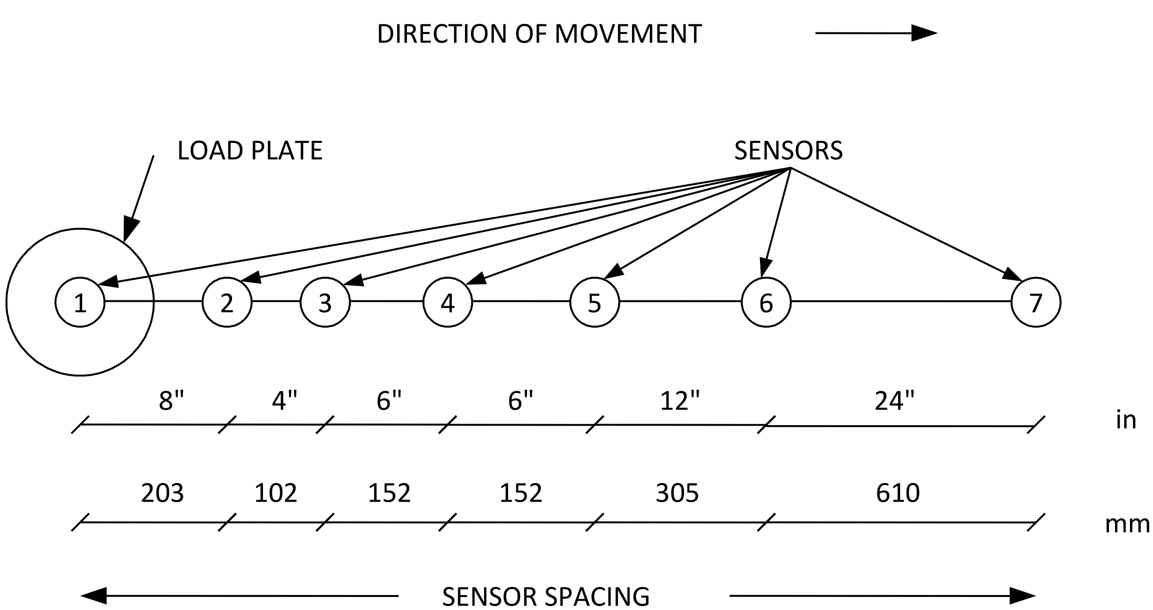

Figure 2. Illustration of FWD sensor configuration for flexible pavements.

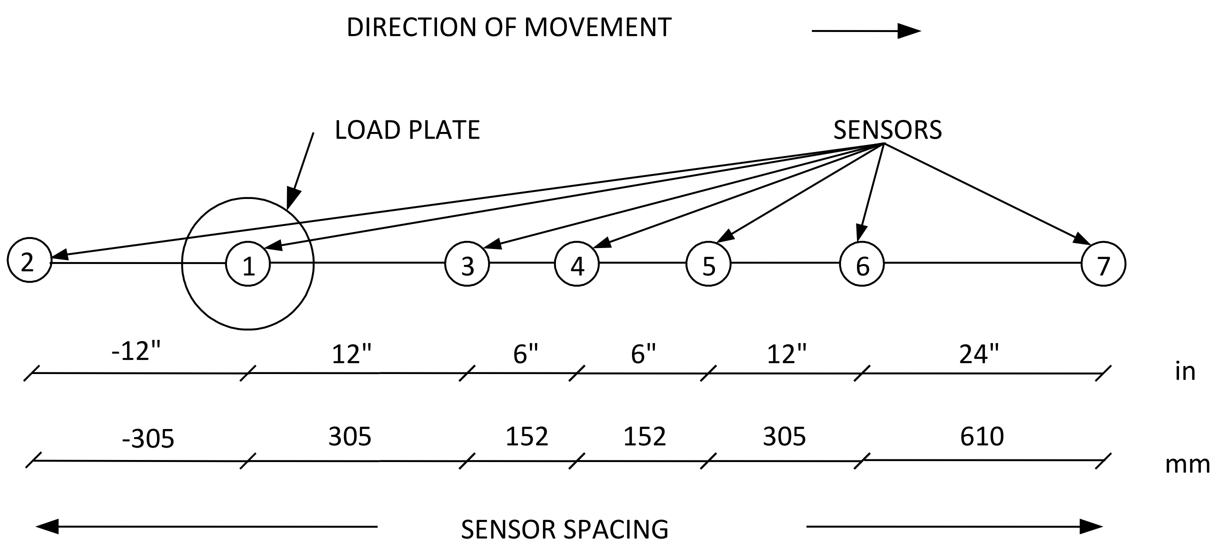

Figure 3. Illustration of FWD sensor configuration for rigid pavements

5. PART A : DEFLECTION TESTING PROCEDURE – FLEXIBLE PAVEMENT

The test procedure for deflection measurements on flexible pavements is described in this section.

5.1 Testing shall be conducted in accordance with the recommendations of the FWD manufacturer, including full calibration of the equipment before the onset of testing, and also as supplemented to reflect the general guidelines provided in this guide.

5.2 Testing for all pavement types may be performed during day time or night time depending on the study objectives. Adequate traffic control shall be provided for testing.

5.3 Testing conducted on two-lane projects shall be greater than one mile long, or on multi-lane projects greater than half mile long. Testing frequency for two-lane projects is 28 tests per mile in one direction. For multi-lane projects, testing is conducted at 14 tests per mile per direction. Occasionally, special circumstances may require testing of a project length less than the typical minimum requirements. On these occasions, testing frequency should be increased in order to achieve a minimum of 28 tests per project for two lane roads and 14 tests per project per direction for multiple lane roads.

5.4 For each pavement test section, information that includes, but not limited to the following shall be recorded: project location, operator name, date and time, calibration factors, beginning and ending of the test section, culvert, bridges, limits and extent of surface distress, drainage conditions, weather conditions, and description of the pavement type.

5.5 The test locations shall be as clean as possible. Remove all loose material and debris to ensure a proper seating of the loading plate and sensors.

5.6 At a minimum, measure the ambient air temperature and pavement surface temperature at each test site.

Note 1: The present approach for predicting pavement design embankment modulus does not require temperature adjustment for deflection data.

5.7 Set up the data acquisition system for data collection.

5.8 Input the information that identifies the exact configuration of the deflection device at the time of testing. This information usually includes the size of load plate, number and spacing of deflection sensors, and the orientation of deflection sensors with respect to the load plate. The sensor spacing is specified as 0”, 8”, 12”, 18”, 24”, 36” and 60” for a seven sensor system.

5.9 Select the appropriate data file format compatible with FDOT formatting.

5.10 Lower the loading plate and sensors and ensure that they are resting, and in full contact with a firm and stable pavement surface.

5.11 Raise the force generator to the desired height that would result in the desired impact load and drop the “weight”. Record the resulting peak surface deflections and peak load, and the time histories.

5.12 When testing with the FWD for pavement design purposes on flexible pavement, two 9,000 lb. (40 kN) load drops are used. The first drop is used to “seat” the loading plate and deflection data resulting from the last drop are considered for roadbed soil characterization. Comments should be added to the data file while testing to describe any distresses or conditions that may influence deflection data or pavement performance.

6. PART B : DEFLECTION TESTING PROCEDURE – RIGID PAVEMENT

The test procedure for deflection measurements on rigid pavements (PCC) is described in this section. Testing on rigid pavements is primarily to evaluate load transfer efficiency of slab joints in rigid pavement.

6.1 The testing shall be conducted in accordance with the recommendations of the FWD manufacturer, including full calibration of the equipment before the onset of the testing, and as per research/forensic study objectives.

6.2 Testing may be conducted in either the left / right wheel paths, or middle of lanes across the joint for joint efficiency measurements.

6.3 For joint approach testing, the edge of the load plate should be positioned on the approach slab within 2 inches (50 mm) of the joint, but under no circumstances should it bridge the joint. Figure 4 shows the configuration for joint approach testing.

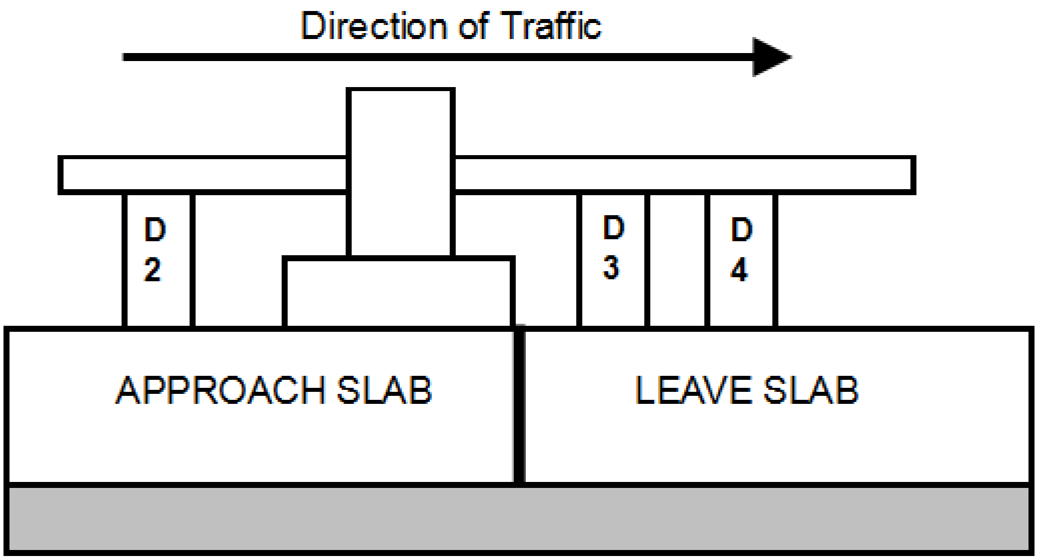

Figure 4. Joint Approach Testing

6.4 Testing for the joint leave requires the FWD load plate to be positioned on the leave slab within 2 inches (50 mm) of the joint, but under no circumstances should it bridge the joint. Figure 5 shows the configuration for joint leave testing.

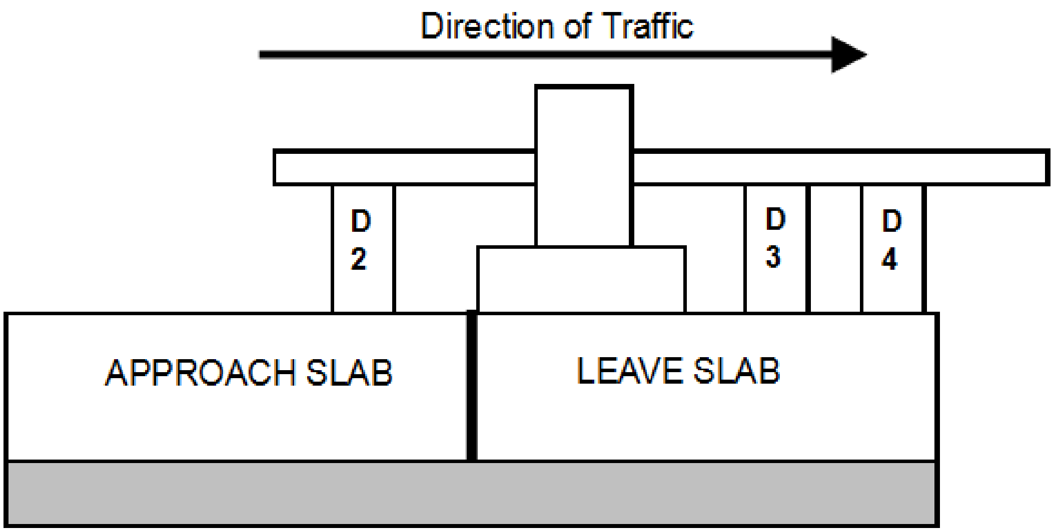

Figure 5. Joint Leave Testing

6.5 Mid-panel testing should be performed with the load plate located within 1 ft. (0.3 m) or 10 percent of the effective slab length of the center (as measured along the test pass), whichever is smaller.

6.6 For corner testing, the edge of the load plate should be within 3 inches of the joint and the longitudinal edge.

6.7 For each pavement test section, information that includes, but not limited to the following shall be recorded: project location, operator name, date and time, calibration factors, location joints, culvert, bridges, limits and extent of surface distress, drainage condition, weather condition, and description of the pavement type.

6.8 The test locations shall be as clean as possible. Remove all loose material and debris to ensure a proper seating of the loading plate.

6.9 At a minimum, measure the ambient air temperature and pavement surface temperature at each test site.

6.10 Set up the data acquisition system for data collection.

6.11 Input the information that identifies the exact configuration of the deflection device at the time of testing. This information usually includes the size of load plate, number and spacing of deflection sensors, and the orientation of deflection sensors with respect to the load plate. The sensor spacing is specified as -12", 0", 12", 18", 24", 36" and 60" for a seven sensor system.

6.12 Select the appropriate data file format compatible with FDOT formatting.

6.13 Lower the loading plate and sensors and ensure that they are resting, and in full contact with a firm and stable pavement surface.

6.14 Raise the force generator to the desired height and drop the “weight”. Record the resulting peak surface deflections and peak load, and the time histories if needed.

6.15 Perform one seating drop, and two or more load drops depending on the study objective. Comments should be added to the data file during testing to describe any distresses or conditions that may influence deflection data or pavement performance.

7. REPORT

7.1 At a minimum, the following should be reported:

7.1.1 Project information should include: project ID, requested beginning and ending mileposts, roadway direction, and other relevant information.

7.1.2 Survey date, surface condition and weather conditions.

7.1.3 Identification of test position (e.g., R – right lane, L – left lane, JA – joint approach, JL – joint leave).

7.1.4 Identification of the FWD ID, Operator.

7.1.5 Deflection plots.

7.1.6 Recommended Design Embankment Modulus, Mr. on flexible pavements for pre-design purposes, Load Transfer Efficiency (LTE %) and backcalculated moduli of pavement layers.

8. CALIBRATION

8.1 Relative calibrations must be performed at least once in 30 days of project testing according to the manufacturer’s guidelines to ensure deflections measured by the FWD sensors are within the precision limits as specified in section 8.2 of ASTM D4694.

8.2 Based on relative calibration results, the calibration factors for the sensors are entered into the FWD software as multipliers. This result in a set of measurements that have been corrected to agree with the calibration instrumentation.

8.3 The distance measurement instrument (DMI) must be calibrated within 30 days of project testing. A measured mile is located on CR 1474, east of SE 163rd Street in Gainesville as a reference.

8.4 Reference calibration must be conducted annually at a Strategic Highway Research Program (SHRP) designated facility to verify the load cell and sensors are capable of precise and accurate measurements.

9. PRECISION

9.1 Repeatability precision on flexible pavement within the same FWD unit should not differ by more than 0.29 mils at a 95 percent confidence level for deflections measured on flexible pavements at a radial distance of 36 inches using the same FWD unit and a 9,000 lb. (40 kN) load on the same test site (Research Report FL/DOT/SMO/03-468).

9.2 Reproducibility precision on flexible pavement between different FWD units should not differ by more than 0.40 mils at a 95 percent confidence level for deflections measured on flexible pavements at a radial distance of 36 inches using two different FWD units and 9,000 lb. (40 kN) load on the same test site (Research Report FL/DOT/SMO/03-468).