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Standard Guide for General Pavement Deflection Measurements[1]

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1. Scope

1.1 This guide provides procedural information for measuring pavement surface deflections, directly under, or at locations radially outward (offset) from a known static, steady-state, or impulse load. Deflections are measured with sensors that monitor the vertical movement of a pavement surface due to the load. This guide describes procedures for the deflection measurement using various deflection testing devices and provides the general information that should be obtained regardless of the type of testing device used.

1.2 This Guide is applicable for deflection measurements performed on flexible asphalt concrete (AC), rigid portland cement concrete (PCC), or composite (AC/PCC) pavements. Rigid pavements may be plain, jointed, jointed reinforced, or continuously reinforced concrete.

1.3 The values stated in SI units are to be regarded as standard. Inch-pound units given in parentheses are for information purposes only.

1.4 *This standard may involve hazardous materials, operations, and equipment. This standard 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 standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:* [2]

D 4602 Nondestructive Testing of Pavements Using Cyclic-Loading Dynamic Deflection Equipment

D 4694 Deflections With a Falling-Weight-Type Impulse Load Device

D 5858 Guide for Calculating In Situ Equivalent Elastic Moduli of Pavement Materials Using Layered Elastic Theory

2.2 *AASHTO Standard:*[3]

T256—Standard Method of Test for Pavement Deflection Measurements

PDDX —Pavement Deflection Data Exchange—Technical Data Guide, Version 1.0, April 1998

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *deflection basin, n*—The bowl shape of the deformed pavement surface due to a specified load as depicted from the peak measurements of a series of deflection sensors placed at radial offsets from the center of the load plate.

3.1.2 *deflection basin test, n*—A test with deflection sensors placed at various radial offsets from the center of the load plate. The test is used to record the shape of the deflection basin resulting from an applied load. Information from this test can be used to estimate material properties for a given pavement structure.

3.1.3 *deflection sensor, n*—Electronic device(s) capable of measuring the relative vertical movement of a pavement surface and mounted in such a manner as to minimize angular rotation with respect to its measuring plane at the expected movement. Such devices may include seismometers, velocity transducers, or accelerometers.

3.1.4 *load cell, n*—Capable of accurately measuring the load that is applied perpendicular to load plate and placed in a position to minimize the mass between the load cell and the pavement. The load cell shall be positioned in such a way that it does not restrict the ability to obtain deflection measurements under the center of the load plate. The load cell shall be water resistant, and shall be resistant to mechanical shocks from road impacts during testing or traveling.

3.1.5 *load plate, n*—Capable of an even distribution of the load over the pavement surface. load plates may be circular in shape (or rectangular in some cases), one piece or segmented, for measurements on conventional roads and airfields or similar stiff pavements. The plate shall be suitably constructed to allow pavement surface deflection measurements at the center of the plate.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from the American Association of State Highway and Transportation Officials, 444 N. Capitol St., NW, Washington, DC 20001.

3.1.6 *load transfer test*, *n*—A test, usually on PCC pavement, with deflection sensors on both sides of a break or joint in the pavement. The test is used to determine the ability of the pavement to transfer load from one side of the break to the other. Also, the load-deflection data can be used to predict the existence of voids under the pavement.

3.1.7 *test location, n*—The point at which the center of the applied load or loads are located.

4. Summary of Guide and Limitations

4.1 This guide consists of standards for measuring pavement surface deflections directly under and/or at appropriate offset locations from the load center. Each nondestructive testing (NDT) device is operated according to the standard operating procedure applicable to the device.

4.2 This guide includes general descriptions of the various types of static and semicontinuous deflection testing devices, and procedures for deflection measurement corresponding to each testing device.

4.3 The collection of general information described in this guide, such as test setup, ambient temperature, pavement temperature, equipment calibration, number of tests, and test locations, pertain to all devices.

5. Significance and Use

5.1 NDT measurement of pavement surface deflections provides information that can be used for the structural evaluation of new or in-service pavements. These deflection measurements may be used to determine the following pavement characteristics:

5.1.1 Modulus of each layer.

5.1.2 Overall stiffness of the pavement system.

5.1.3 Load transfer efficiency of PCC pavement joints.

5.1.4 Modulus of subgrade reaction.

5.1.5 Effective thickness, structural number, or soil support value.

5.1.6 Bearing capacity or load carrying capacity of a pavement.

5.2 These parameters may be used for the analysis and design of reconstructed and rehabilitated flexible and rigid pavements, pavement structural adequacy assessment including joint efficiency of PCC pavement, void detection in PCC pavement, research and/or network structural inventory purposes.

6. Apparatus

6.1 The apparatus used in this Guide shall be one of the deflection measuring devices described in subsection 6.2 and shall consist of some type of probe or surface contact sensor(s) to measure vertical pavement movements or deformations when subjected to a given load.

6.2 *Deflection Measuring Devices*:

6.2.1 *Noncontinuous Static Device*,[4] that operates on a single lever-arm principle. This device shall have a minimum 2.5 m (8.2 ft.) long probe, and the extension of the probe shall depress a dial gage or electronic sensor that measures maximum pavement surface deflection with a resolution of 0.025 mm (0.001 in.) or better. The vehicle used to impart the wheel load to the pavement shall be a truck capable of carrying a minimum 80 kN (18,000 lbf) test load on a single rear axle. The loading configuration, including axle loads, tire sizes, and inflation pressures, can be obtained using the manufacturer's specification; however, this information must be clearly indicated in the engineering report.

6.2.2 *Semicontinuous Static Device,*[5] that operates on a double lever-arm principle. The vehicle used to carry this device shall be a truck carrying a 130 kN (29,000 lbf) single axle test load. The loading configuration including axle loads, tire sizes, and inflation pressures can be obtained using the manufacturer's specification; however, this information must be clearly indicated in the engineering report. The test vehicle shall be equipped with a double lever arm with probes, the geometry and size of which makes it possible to measure the maximum pavement surface deflection in both wheel paths with a resolution of 0.025 mm (0.001 in.) or better. The extension of each lever arm holding the probe shall depress an electronic sensor, which may be of any type provided the sensor delivers an analog or digital signal. The digital signal shall be correlated with the movement of this extension and, therefore, with the deflection of the pavement surface under the effect of the moving test load. The truck shall be able to lift and move the probes from one measurement point to the next, lower them onto the pavement surface, and make another set of measurements in a fully automated process at a constant vehicle speed.

6.2.3 *Steady State Dynamic Device,*[6] that uses a dynamic force generator to produce a dynamic load. The force generator may use, for example, a counter rotating mass or a servo-controlled hydraulic actuator to produce the dynamic load. The device that uses a counter rotating mass operates at a fixed frequency to produce a dynamic load under a static weight applied through a pair of rigid steel wheels. Both loading frequency and the magnitude of the dynamic loads may be varied by the operator of the devices that use a servo-controlled hydraulic actuator. Depending on the model, normal operating frequencies range from 8 to 60 Hz and maximum dynamic forces range from 2.2 to 35.5 kN (500 to 8000 lbf) applied through a single circular or dual rectangular plate, or dual steel wheels such as those used on the standard Dynaflect device. A steady-state loading device may be mounted in a van, on the front of a vehicle, or on a trailer. Deflection measurement devices should have five or more sensors to satisfactorily measure the deflection basin with a resolution of 0.002 mm (0.0001 in.) or better.

6.2.4 *Impulse Device,*[7] that creates an impulse load on the pavement by dropping a mass from a variable height onto a rubber or spring buffer system. Generically known as a Falling Weight Deflectometer (FWD), the force generating device shall be capable of being raised to one or more predetermined

[4] An example of this instrument is the Soiltest Benkelman Beam.

[5] An example of this instrument is the Lacroix Decflectograph.

[6] Examples of this instrument are the Geolog Dynaflect and the Foundation Mechanics Road Rater.

[7] Examples of this instrument are the Dynatest Falling Weight Deflectometer (FWD), the KUAB 2m-FWD, the Carl Bro FWD, and the Jils FWD.

TABLE 1 Load Cell Frequency of Calibration

Device Type	Frequency of Calibration
Noncontinuous and Semicontinuous Static Loading Types	Prior to testing
Steady-State Loading Types (see 7.2.2 for devices that do not have a load cell)	At least once a year using the manufacturer's instructions on using the procedure in Appendix A of SHRP Report SHRP-P-661
Impulse Loading Types (Falling Weight Deflectometer)	At least once a year using the procedure in Appendix A of SHRP Report SHRP-P-661

TABLE 2 Deflection Sensor Frequency of Calibration

Device Type	Frequency of Calibration	Minimum Frquency of Calibration Check
Noncontinuous and Semicontinuous Static Loading Types	Daily during operation	Daily during operation
Steady-State Loading Types	At least once a year	Once a month during operation
Impulse Loading Types (Falling Weight Deflectometer)	Reference calibration at least once a year using the procedure in Appendix A of SHRP Report SHRP-P-661	Relative calibration once a month during operation using the procedure in Appendix A of SHRP Report SHRP-P-661

heights and dropped. The resulting force, transmitted to the pavement through a circular load plate, shall not vary between repetitive drops by more than ± 3%. The force pulse shall approximate the shape of a haversine or half-sine wave and a peak force in the range of 7 to 105 kN (1,500 to 24,000 lbf) shall be achievable. The impulse loading device shall measure pavement surface deflections using seven or more sensors with a resolution of 0.002 mm (0.0001 in.) or better.

7. Calibration of Deflection Measuring Devices

7.1 The deflection sensor(s) and load cell (if applicable) of the deflection device should be calibrated to ensure that all readings are accurate within specified limits. For devices where the load is assumed to be constant and is not measured, the accuracy of the magnitude of load imparted should be checked periodically using the manufacturer's recommended calibration procedure.

7.2 *Load Cell*:

7.2.1 *General*—The procedure for calibrating the load cell (if the device uses a load cell) is dependent upon the type of device used. The calibration of load cell may be checked informally by observing the load cell readings and comparing them against expected readings based on experience or shunt calibration values in the case of Falling Weight Deflectometer or the Road Rater. Load cell reference (or absolute) calibration shall be performed at least once a year except the noncontinuous and semicontinuous loading devices (see Table 1).

7.2.2 *Noncontinuous and Semicontinuous Static Loading Devices*—Immediately prior to testing, weigh the axle load of the truck if the ballast consists of a material that can absorb moisture (sand or gravel, and so forth) or could have changed for any reason. Trucks with steel or concrete block loads only need to be weighed if the loads are changed or could have shifted.

7.2.3 *Impulse Loading Device*—Reference load cell calibration should be carried out at least once per year. Appendix A of SHRP Report SHRP-P-661 contains an example outline for such a task.

7.3 *Deflection Sensors*:

7.3.1 *General*—The procedure for calibrating the deflection sensors is dependent upon the type of apparatus used. Calibration of the deflection sensors should be checked at least once a month during production testing except noncontinuous and semicontinuous loading devices (see Table 2).

7.3.2 *Noncontinuous and Semicontinuous Static Loading Devices*—Static loading devices should be calibrated daily with feeler gages. When performing deflection sensor calibration, induced deflections should be similar in magnitude to the deflections encountered during normal testing.

7.3.3 *Steady-State Loading Devices*—A routine calibration check of the deflection sensors shall be conducted once a month. If significant differences are noted for a sensor, it shall be returned to the manufacturer for check or calibration under standard calibration oscillatory vibrations. Deflection sensors shall be calibrated annually.

7.3.4 *Impulse Loading Devices*—Reference deflection sensor calibration should be carried out in accordance with the SHRP Protocol (see Appendix A of SHRP Report SHRP-P-661 for impulse loading devices). A relative calibration check should be conducted once a month using the SHRP Protocol (see Appendix A of SHRP Report SHRP-P-661).

7.4 *Temperature Sensors*:

Pavement temperature sensor calibration should be carried out using a calibrated reference thermometer and two reference surfaces such as a "cool" and "hot" surface. Air temperature sensor (if equipped) calibration should be carried out using two reference temperatures, for example, carefully monitored ice water (0°C) and hot water (60°C). Calibration of temperature sensors should be carried out at least once a year.

8. Field Data Collection and Testing Procedures

8.1 *General*—The procedure to be followed is, to some extent, dependent upon which type of device is used. The following general information is suggested as the minimum data that needs to be collected, regardless of the type of device used.

8.1.1 *Load*—For impulse loading devices, record the peak load applied to the pavement surface by the deflection device. For steady-state loading devices, record the peak-to-peak load and load configuration. For static loading devices, record the axle load, tire pressure, type and size, and the load configuration (dual spacing) of the test vehicle.

8.1.2 *Load Frequency*— If applicable, record the frequency of calculated oscillatory load for vibratory loading devices.

NOTE 1—For some devices, the manufacturer generally presets the cyclic loading frequency at a default value of 8 Hz.

8.1.3 *Geometry of Loaded Area and Deflection Sensor Locations*—For proper modeling of the pavement structure and/or backcalculation of layer parameters, etc., it is necessary that the locations of the load, deflection sensors, pavement surface cracks, and PCC joints are known and recorded. Record the location of cracks and joints between the load and each sensor within 2 m (6.5 ft.) from the center of the load toward the sensors. Record the location and orientation of all sensors as measured radially outward from the center of the load, for example, "300 mm (11.8 in.) ahead of the applied load." In accordance with the selected method of evaluating joint efficiency or load transfer, the load(s) and deflection sensor(s) should be properly configured and noted, for example tests may be conducted with one or more sensors on each side of the joint, with the load plate positioned immediately adjacent to the leave (downstream) side of the joint. Other configurations may also be used. Failure to note the presence of joints and cracks within the zone of influence of the load could result in errors in the subsequent analysis of the recorded deflections. Similarly, failure to properly note the actual position of the deflection sensors could result in serious analysis errors.

8.1.4 *Time of Test*—Record the time for each measurement location.

8.1.5 *Stationing or Chainage*—Record the station number or location of the test point for each deflection test conducted.

8.1.6 *Air and Pavement Temperatures*—At a minimum, record the ambient air temperature and pavement surface temperature at specified intervals as recommended by the engineer. Additional temperatures may be required for specific post-processing methods. For example, pavement layer temperatures may be determined by drilling holes to one or more depths within the pavement layer and filling the bottom of these holes with 10 to 15 mm (⅓ to ⅔ in.) of a fluid that has a low evaporation rate (to prevent cooling), such as glycerin or an oil-based product, and recording the temperature at the bottom of each hole after the temperature in the fluid has stabilized. If testing is conducted over an extended period of time, take temperature measurements of the fluid every hour to establish a direct correlation between the air, pavement surface, and/or at-depth temperature measurements. If this is not possible, some procedures[8] also exist for estimating the pavement temperature as a function of depth using the high and low air temperatures for the previous 24-hour day and the current pavement surface temperature.

8.2 *Testing Interval*—The spacing or interval of field test locations is dependent upon the testing level selected, as discussed in Section 9 of this standard.

8.3 *Testing Method*—Depending on the type of apparatus used, different testing methods can be used. Steady-state loading devices capable of variable loads and frequencies can be used to conduct "frequency sweeps" (multiple tests at various frequencies, at the same test location and load). Impulse loading devices are typically capable of applying various loads; some devices can control the shape and duration of the load pulse. Joint efficiency measurements on jointed PCC pavements can be carried out with devices equipped with multiple deflection sensors, by placing the load on one side of the joint and positioning one or more sensors on each side of the joint. Using a Benkelman Beam device, load transfer measurements can be conducted by using two devices, one on each side of the joint as the loaded truck axle slowly crosses the joint.

8.4 *Procedure for Deflection Measurements*:

8.4.1 *General*—Procedures for conducting the specific deflection testing should be those furnished by the manufacturer of the device, as supplemented to reflect the general guidelines provided in this standard. The following steps shall be performed irrespective of the device used.

8.4.1.1 Calibrate the deflection sensor(s) and load cell (if applicable) of the device, following the procedure discussed in Section 7.

8.4.1.2 Transport the device to the test location over the desired test point.

8.4.1.3 Measure the ambient air temperature and pavement temperatures in accordance with the guidelines in 8.1.6.

8.4.1.4 Record the following information for each pavement tested: project location, operator name, date and time, calibration factors, the beginning and ending station or physical location such as the "Jct. IH 635 and Beltline Road," location of cut and fill, culvert locations, bridges and other vertical control features, and the limits and extent of surface distresses, weather conditions, and a description of the pavement type.

8.4.1.5 The test location shall be free from all rocks and debris to ensure that the load plate (if applicable) will be properly seated. Gravel or soil surfaces shall be as smooth as possible and all loose material shall be avoided or removed.

8.4.2 *Noncontinuous Static Loading Device*:

8.4.2.1 Position the beam between the tires so that the probe is 1.37 m (4.5 ft.) forward of and perpendicular to the rear axle. Note whether the right- or left-hand set of dual tires is used (or both in the case of two beams).

8.4.2.2 Adjust the dial gage to read 0.000 mm (0.000 in.) or note the reading prior to starting the test sequence.

8.4.2.3 Drive the test vehicle approximately 8 m (25 ft.) forward at creep speed and record the maximum dial reading (Dm) with a resolution of 0.025 mm (0.001 in.) or better.

8.4.2.4 After the dial needle has stabilized, record the final dial reading (Df) with a resolution of 0.025 mm (0.001 in.) or better.

8.4.2.5 Calculate the surface deflection using the manufacturer's recommended formula, which is based on the configuration of the pivot on the beam.

8.4.2.6 Repeat this process at the measurement intervals specified in Section 9. Normally, both wheel tracks are measured using two instruments. However, when testing with only one instrument, the testing can be either be in the outer wheel track (usually most critical), or it can be alternated

[8] Federal Highway Administration: "Temperature Predictions and Adjustment Factors for Asphalt Pavements," Report No. FHWA-RD-98-085.

between wheel tracks, for example by obtaining two measurements in the outer wheel track for every one measurement in the inner wheel track throughout the test section.

8.4.2.7 Report the individual measurements, along with the average (mean) deflection for each wheel track and the standard deviation of these measurements, for each uniform test section.

8.4.3 *Semicontinuous Static Loading Device*:

8.4.3.1 Obtain pavement surface deflection measurements for both wheel tracks as specified in Section 9 on a continuous chart.

8.4.3.2 Read the deflection measurements from the deflection traces with a resolution of 0.025 mm (0.001 in.) or better, and tabulate using deflection data sheets along with any accompanying notes.

8.4.3.3 For each uniform test section, calculate the average (mean) deflection measurements for both wheel tracks, and report these data along with the tabulated data and accompanying notes from 8.4.3.2.

8.4.4 *Steady-State Loading Device*:

8.4.4.1 Set up the software for data collection if the device is so equipped.

8.4.4.2 Record the information that identifies the exact configuration of the deflection device at the time of testing. The device configuration data usually includes number and spacing of deflection sensors and orientation of the deflection sensors.

8.4.4.3 Locate the device such that the center of load is at the selected test location and the sensor bar is parallel to the direction of travel (or across the joint for longitudinal or skewed joints).

NOTE 2—When testing longitudinal joints with a steady-state device, a sensor can be mounted transversely to the load plate.

8.4.4.4 Lower the sensor bar to position the sensors and the load plate (or plates), or loading wheels. Initiate force generation until stability is reached at the selected loading frequency and load magnitude.

NOTE 3—When using a steady-state device, the first few vibrations are unstable in terms of output because the sensors may not have fully responded to the selected output frequency.

8.4.4.5 Record the frequency and magnitude of the peak-to-peak steady-state load.

8.4.4.6 Record the static preload, as this will influence the magnitude of the deflection.

8.4.4.7 Read and record the measured deflections for each of the sensors, either manually on data sheets or directly if data recording is automated.

8.4.5 *Impulse Loading Device*:

8.4.5.1 Set up the software for data collection.

8.4.5.2 Input the information that identifies the exact configuration of the deflection device at the time of testing. The device configuration data are stored in the data output file and are a direct input to data analysis. This information usually includes the size of load plate, number and position of deflection sensors, and the orientation of deflection sensors with respect to the load plate.

NOTE 4—When testing longitudinal joints with an impulse loading device, a sensor can be mounted transversely to the load plate.

8.4.5.3 Select the appropriate data file format. Several file formats are available, for example, U.S. Customary units, SI units, and other options.

8.4.5.4 Lower the load plate and sensors to ensure that they are resting on a firm and stable surface.

8.4.5.5 Raise the force generator to the desired height and drop the "weight." Perform one or more test drop(s) at any load level. One or more "seating" drops may also be used; however record the data from the seating drops, which can subsequently be used in the analysis to ascertain the amount of "conditioning" the pavement itself experiences, if any. Record the peak surface deflections and peak load (noting the seating drops), or record the full load response and deflection-time history, as recommended by the engineer.

8.4.5.6 To allow the engineer to determine the nonlinearity of the pavement system, testing at multiple load levels can be carried out. The analyst may use basin averaging if random error is of sufficient concern.

9. Location and Sampling Frequency

9.1 The test location will vary with the intended application of the data. For the most part, the common approach is to test primarily in wheel paths, since the pavement response at these locations to some extent reflects the effect of damage that has been accumulated. Deflection testing between wheel paths on AC pavement may be performed to compare testing in the wheel paths to indicate differences that may be present, for example due to wheel path cracking.

9.2 *Network Level Testing*—This testing level provides for a general overview of a pavement's bearing capacity with limited testing. Deflection testing is typically performed at 100 m to 500 m (or 250 ft. to 1,000 ft.) intervals, depending on the specific pavement conditions and the length of the pavement section. A minimum of 7 tests per uniform pavement section is recommended to ensure a statistically significant sample. At a minimum, the load for asphalt concrete (AC) and continuously reinforced concrete pavements (CRCP) should be positioned along the outer wheel path, or alternatively along the centerline of CRCP slabs. For jointed concrete pavements (JCP), the load should first be positioned at the geometric center of the slab. For network level testing, at least 10 % of the slabs covered should be tested at the joints as well, for deflection or load transfer efficiency.

9.3 *General Project Level Testing*—This testing level provides for a more detailed analysis of the pavement, for example for the purpose of overlay or rehabilitation design. Testing should be performed at 50 m to 200 m (or 100 ft. to 500 ft.) intervals, depending on the specific pavement conditions and the length of the pavement section. A minimum of 15 tests per uniform pavement section is recommended for general project level testing. At a minimum, the load for AC or CRCP pavements is generally positioned along the outer wheel path, or alternatively along the centerline of CRCP slabs. For JCP pavements, the load should first be positioned at or near the geometric center of the slab, and then moved to the nearest joint and positioned along the same line, generally on the leave side of the joint. On roads, streets and highways, joint tests are often conducted along the outer wheel path. For general project level testing, as a rule not every joint associated with each interior slab test is covered; however, a minimum joint coverage rate of 25 % is recommended. On airfield JCP pavements, joint efficiency measurements should be carried out on both transverse and longitudinal joints.

9.4 *Detailed Project Level Testing*—This test level provides for a highly detailed and specific analysis of the pavement, for purposes such as identifying localized areas of high deflection or detecting subsurface voids on PCC pavements, etc. For AC or CRCP pavements, testing is typically performed at 10 m to 100 m (or 25 ft. to 250 ft.) intervals as recommended by the engineer. On roads, streets and highways, testing is often carried out in both wheel paths. For JCP pavements, the load should first be positioned at or near the geometric center of every slab along the length of the test section, and then moved to the nearest joint or crack on each slab, either along the outer wheel path or at the corner of the slab, or both. On airfield JCP pavements, joint efficiency measurements should be carried out on both transverse and longitudinal joints.

10. Other Data Needed for Deflection Analysis

10.1 The following pavement system data may be needed to facilitate the load-deflection analysis:

10.1.1 Pavement layer material types and thicknesses.

10.1.2 Depth to bedrock or stiff layer.

11. Deflection Testing Report

Field reports (both electronic and hard copy) for each deflection testing evaluation project should contain information on the following items as a minimum.

11.1 Date and time of testing.

11.2 Operator identification.

11.3 Vehicle information.

11.4 Weather conditions.

11.5 Air and pavement temperatures.

11.6 Section Information– this is usually agency-specified, but the section information generally includes the following:

11.6.1 Roadway and county or district in which it is located.

11.6.2 Type of pavement being tested.

11.6.3 Direction of travel.

11.6.4 Lane being tested (for example, driving or passing lane), and the position within the lane (inner wheel path, mid-lane, outer wheel path, and so forth).

11.7 Load and deflection data.

11.7.1 Type of deflection device.

11.7.2 Type of deflection test, such as deflection basin or load transfer.

11.7.3 Location of sensors.

11.7.4 Applied load and load frequency.

11.7.5 Measured deflections under load.

12. Data Acquisition Software

12.1 Some deflection testing devices use their own field program to acquire load and deflection data. Traditionally, pavement surface deflection data files have been structured using ASCII formats that are very device dependent. Although ASCII format allows users and agencies to easily access the data output files, a separate program is needed to access the output file for each type of testing device. To mitigate this problem, AASHTO has developed a universal pavement surface deflection data exchange (PDDX) format specification. A description of this specification can be found in the last reference in 2.2 of this standard.

13. Data Processing Software (for Reference)

13.1 Several backcalculation software programs have been developed for deflection data processing and analysis. ASTM D 5858 provides a discussion of some of the major differences between the most commonly used backcalculation programs. If backcalculation techniques are employed, use the latest program version for backcalculation of pavement layer moduli.

14. Precision and Bias

14.1 Since this Standard Guide covers the use of various NDT devices used on any type of bound pavement surface, the precision and bias of the measured load and deflection data will be a function of both the characteristics of the pavement tested and the device used. Information on reliability, accuracy, and repeatability of various vibratory and impulse loading devices can be found in a report that describes the experiment performed at the Waterways Experiment Station (WES)[9] in Vicksburg, Mississippi.

15. Keywords

15.1 Benkelman beam; deflection sensor; deflection surveys; falling-weight deflectometer (FWD); impulse deflection testing device; load cell; load/deflection testing; nondestructive testing (NDT); pavement surface deflection; pavement testing; sampling frequency; static deflection testing device; steady-state dynamic deflection testing device

[9] Bentsen, Nazarian, and Harrison, "Reliability Testing of Seven Nondestructive Pavement Testing Devices," Nondestructive Testing of Pavements and Backcalculation of Moduli, ASTM STP 1026, A. J. Bush, III and G. Y. Baladi, Eds, American Society of Testing and Materials, Philadelphia, 1989, pp. 41-58.