METHODS OF SAMPLING AND TESTING
MT 422-25
METHOD OF TEST FOR SURFACE SMOOTHNESS AND PROFILE

1 Scope

1.1 This method covers the testing of a finished flexible or rigid pavement surface for smoothness and profile. The surface smoothness is expressed in International Roughness Index (IRI) in units of inches per mile. The surface profile is generated to locate variations in profile (e.g., bumps or dips). This method is not intended to be used with gravel surfacing.

2 Reference Documents

ASTM E950 Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer-Established Inertial Profiling Reference

National Cooperative Highway Research Program (NCHRP) Document 228: Safety Impacts of Intersection Sight Distance

Surface Systems & Instruments, LLC (SSI), Profiler Operations Manual

3 Terminology

3.1 *International Roughness Index (IRI)* – An index resulting from a mathematical simulation of vehicular response to the longitudinal profile of a pavement using a 'quarter-car' simulation model as described in NCHRP Report 228.

4 Apparatus

4.1 *Class I laser road profiler* – as defined in ASTM E950. The road profiling system is mounted on a vehicle, usually a van or truck. It consists of the following components:

4.1.1 *Vertical, non-contact, height measurement systems (i.e., Laser)* – capable of measuring the height from the mounted sensor face to the surface of the pavement.

4.1.2 *A linear distance measuring instrument system (i.e., DMI)* – capable of measuring distance traveled.

4.1.3 *An inertial referencing system (i.e., Accelerometers)* – capable of measuring the movement of the vehicle as it traverses the pavement.

5 Profiler Software

5.1 The profiler software must activate the testing using parameters (i.e., data collection initiation) that are stored by the control setup.

5.2 The software must receive, display, and store raw data received from the profiler.

5.3 The software must be capable of accumulating desired output and printing results.

6 Calibration

6.1 Perform a comprehensive calibration and sensor check every thirty (30) days during construction season. Check the DMI and verify the Laser each day before use.

6.2 Calibration is used to establish and adjust the operating characteristics of the SSI profiler system. There are five (5) items to be either calibrated or checked:

1) Tire Pressure,
2) Laser height,
3) Accelerometer,
4) Bounce Test, and

5) Distance Measuring Instrument.

6.3 Tire Pressure

6.3.1 Check the tire pressure and inflate to tire manufacturer's recommended psi. Special care should be given to the tire on which the DMI device is mounted.

6.4 Laser Height Verification

6.4.1 The lasers are calibrated at the factory; therefore, the lasers can only be verified.

6.4.2 Perform a verification check of the laser each day before use.

6.4.3 Perform a full verification check of the laser sensors whenever problems are suspected, or when a sensor is repaired or replaced.

6.4.4 Facility for Laser Height Verification

6.4.4.1 Each MDT District should have a facility available (e.g.; enclosed garage at District).

6.4.4.2 Facility should have a level surface and be free of vibration.

6.4.5 Procedure for Laser Height Verification

6.4.5.1 Verify laser height in accordance with Section 3.3 of the SSI Operations Manual.

6.5 Accelerometers

6.5.1 Accelerometers need an occasional static verification. Perform static verification:

- every 30 days during times when the system is used frequently,
- after any prolonged period that the system has not been used,
- when repairs are performed on the accelerometer(s) or associated system, or
- any time the system is generating data that appears erroneous or suspect.

6.5.2 Facility for Accelerometer Verification

6.5.2.1 Each MDT District should have a facility available (e.g.; enclosed Garage at District).

6.5.2.2 Facility should have a level surface and be free of vibration.

6.5.3 Procedure for Accelerometer Verification

6.5.3.1 Perform the Accelerometer verification as per Section 3.6 of the SSI Operations Manual.

6.6 Bounce Test

6.6.1 The bounce test is a controlled-conditions procedure that uses the profiler's built-in simulation capabilities to test that the profiling system is operating properly. Perform the bounce test:

- every 30 days during times when the system is used frequently,
- after any prolonged period that the system has not been used,
- when repairs are performed on the accelerometer(s) or associated system, or
- any time the system is generating data that appears erroneous or suspect.

6.6.2 Facility for Bounce Test

6.6.2.1 Each MDT District should have a facility available (e.g.; enclosed garage at District).

6.6.2.2 Facility should have a level surface and be free of vibration.

6.6.3 Procedure for Bounce Test

6.6.3.1 Perform the Bounce Test as per Sections 3.4 and 3.5 of the SSI Operations Manual.

6.7 Distance Measuring Instrument (DMI)

6.7.1 Calibrate DMI whenever problems are suspected, the tires are replaced, suspension repairs are performed, wheels are rotated/ aligned, or repairs are performed on the DMI.

6.7.2 DMI Calibration Site

6.7.2.1 Each MDT District should have a calibration site established.

6.7.2.2 This site should be located on a straight portion of roadway that is reasonably level and has low traffic volume.

6.7.2.3 The site should be measured with a standard surveying tape or wheel, using standard surveying procedures, or laid out using an electronic distance measuring system.

6.7.3 Procedure for DMI Calibration

6.7.3.1 Calibrate the Distance Measuring Instrument (DMI) as per Section 3.2 of the SSI Operations Manual.

6.8 Calibration Record Keeping

6.8.1 SSI software has a Calibration/Verification Report that Tracks DMI Calibration and Accelerometer Verification dates. That report may be printed from any Data Analysis files you may have. A simple record of all calibrations and verifications can be kept with the machine.

7 Project Testing

7.1 Preparation of Surface

7.1.1 Test the roadway only when it is free of moisture and any deleterious material that will not provide accurate test results.

7.1.2 The Contractor is responsible for all work to prepare the roadway for testing, such as, but not limited to sweeping off of debris.

7.1.3 Do not conduct testing if there is moisture on the roadway surface, while it is raining, or under other weather conditions determined inclement by the Engineering Project Manager (EPM).

7.2 Project Setup

7.2.1 The EPM or one of his/her representatives will meet with the Contractor and identify the Beginning-of-Project (BOP), the End-of-Project (EOP), and all excluded areas (e.g., bridges not paved, curves with short radii).

7.2.2 If possible, the beginning and end of the project should be marked for testing using reflective tape or reflective traffic cones to activate the photocell. This is the preferred method. There are three other acceptable methods: back-up to start, manual trigger, or GPS.

7.2.3 If it is not feasible to use the photocell to initiate and stop data collection, data collection can be initiated and stopped manually. When manually initiating and stopping profile data collection, cones should be placed at the beginning and end of the project to be used as reference points by the operator. Follow the profiler manufacturer's recommendations for GPS operations.

7.3 Profiler Operations

7.3.1 Operation of profiler should be consistent with guidelines discussed in the latest version of the SSI Profiler Operations Manual. This includes but is not limited to the following:

- Run in English unit system.
- If possible, initiate data collection via reflective surface and photocell.
- Use approved file naming convention. (Contract#_ProjectName_Lane Direction_Lane_Run#) (example: 09610_Stillwater-N_NB_DL_Run1)
- Document any issues that occurred during testing.
- Process data with software.
- Properly backup data to the respective District Ride Spec share drive archive (Adobe (.pdf) reports, txt files, unedited RSD files, etc.). [\\state\mdt\prd\AppData\RideSpec]
- Provide Adobe (.pdf) and QA Suite (.txt file) reports to the EPM and one of his/her representatives.

7.3.2 MDT collects two comparable runs

Once the operator is confident that a minimum of two comparable runs have been obtained, the Quality Control Review and Bump Reports are used to evaluate the acceptability of the runs. Profiler runs should satisfy the following criteria:

- The average IRI values at each 1 mi (1.61 km) interval for each of the two runs are within ±5.7% of the mean IRI of both runs.
- If spikes (e.g., unusually high IRI) are present in the data, the operator should determine if spikes are pavement related or the result of equipment or operator error. The operator should examine the profile bump reports for discrepancies and features that cannot be explained by observed pavement features.
- Rerun the entire project if any one mile section does not match within the ±5.7% tolerance established above and compare that run to the previous runs.
- Use the results of the two runs that are within the ±5.7% tolerance for project acceptance.
- If the third run does not compare to either of the first two runs, recheck all calibrations. Then rerun the entire project and compare the results to the previous runs. Use the two runs that are within the ±5.7% tolerance for project acceptance.

7.4 Testing Result Reports

7.4.1 Testing result reports shall be provided to EPM and one of his/her representatives and shall be processed into desired segments (e.g., 0.5 miles (2640 feet)) as described in the contract Ride Specification. Segments less than 1000 feet may be combined with an adjacent segment.

7.4.2 A Roughness Report (IRI) (.pdf) and QA Suite (.txt) report will be generated for each profile run deemed acceptable within the comparison values for each lane profiled. This report will contain the IRI values for the left and right wheel paths. These IRI values will be applied to the most recent pay incentives/disincentives as described in Ride Specification.

7.4.3 A Bump Report (profile defects) will be generated foreach profile run deemed to be error free for each lane profiled. The Bump Report will indicate the locations of potential defects. These will be reviewed with the EPM. Locations should be physically examined to determine if, at the EPM's discretion, the location should be considered a defect.