
Standard Equipment Specification for

Inertial Profiler

AASHTO Designation: MP 11-08 (2008)¹



1. SCOPE

- 1.1. The objective of this specification is to define the required attributes of an inertial profiling system (IPS) to measure a longitudinal pavement profile for construction quality control and acceptance. The system shall be able to calculate summary roughness indices, particularly the International Roughness Index (IRI). This specification is designed to apply to both low-speed and high-speed profilers.
- 1.2. The system shall be capable of outputting the profile as a temporary display, a printed record, or a data file.
- 1.3. It is not the intent of this specification to relieve the supplier from the final responsibility to provide an appropriate product for the intended function nor is it intended to specify all the design details. The objective is to provide a sufficiently detailed specification that the function is clearly defined. It is intended to be sufficiently detailed that the data collected from multiple systems will be identical.

2. REFERENCED DOCUMENTS

- 2.1. *AASHTO Standards:*
- MP 17, Pavement Ride Quality When Measured Using Inertial Profiling Systems
 - PP 49, Certification of Inertial Profiling Systems
 - PP 50, Operating Inertial Profilers and Evaluating Pavement Profiles
 - R 43M/R 43, Quantifying Roughness of Pavements
- 2.2. *ASTM Standards:*
- E 867, Standard Terminology Relating to Vehicle-Pavement Systems
 - E 950, Standard Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer Established Inertial Profiling Reference
 - E 1082, Standard Test Method for Measurement of Vehicular Response to Traveled Surface Roughness
 - E 1170, Standard Practices for Simulating Vehicular Response to Longitudinal Profiles of Traveled Surfaces
 - E 1489, Standard Practice for Computing Ride Number of Roads from Longitudinal Profile Measurements Made by an Inertial Profile Measuring Device
 - E 1926, Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements

3. TERMINOLOGY

3.1. Definitions:

- 3.1.1. *accelerometer*—transducer that provides an output proportional to acceleration.
- 3.1.2. *aliasing*—the term used to describe the error that can result when a signal is sampled at a rate less than twice the frequency of the various sinusoidal components that compose the signal. To avoid aliasing, the signal is band limited so that the sampling frequency used will be greater than twice as high as the highest frequency component in the signal. It is also described as the error that results from sampling a long wavelength signal that is mixed with a short wavelength noise signal.
- 3.1.3. *anti-aliasing filter*—a low-pass analog filter that suppresses short wavelength contamination of longer wavelength measurements to improve the accuracy of the sampling process.
- 3.1.4. *bandwidth*—measure of how rapidly a reading fluctuates with time; hence, the greater the bandwidth, the faster the variation in the signal.
- 3.1.5. *continuous IRI*—a series of IRI values calculated over a running interval, one for each profile data point throughout the test section. Each IRI value is provided at the midpoint of the running interval.
- 3.1.6. *filtering*—procedure to extract desired information from a signal that also contains unwanted information (commonly called noise). Digital filtering is a calculation procedure that takes one set of numbers and transforms them into another set in which the noise is reduced. Moving average is one type of such transform or filter.
- 3.1.7. *high-pass filtering*—reduces the effect of long wavelengths that are associated with gradual elevation changes such as hills.
- 3.1.8. *index*—measure or standard. Within the context of this test method, a suitably chosen index quantifies the ride quality of a pavement.
- 3.1.9. *infrared laser sensor*—non-contacting transducer that provides an output proportional to the distance from the sensor to a reflecting surface. These sensors are mounted at a nominal height, or standoff, above the roadway surface when the test vehicle is in the static position.
- 3.1.10. *low-pass filter*—smoothing type filter that reduces the effect of short wavelengths that are associated with rapid elevation changes such as expansion joint ribs.
- 3.1.11. *measurement range*—the detectable range of heights, measurable by the sensor.
- 3.1.12. *moving average*—filtering process whereby each data point is replaced with the average value of several adjacent points or elevations. It is a smoothing process because the changes from one elevation point to the next will not be as significant due to the fact that that difference has been divided by the total number of data points in the averaging scheme. It is a type of low-pass filter.

- 3.1.13. *profile*—two-dimensional slice of the roadway surface, taken along an imaginary line, such as the wheelpath, in the longitudinal or travel direction. It represents the perpendicular deviations of the pavement surface from an established reference parallel to the horizontal.
- 3.1.14. *reference line*—the imaginary line formed by the infrared laser sensor and the accelerometer in a static mode.
- 3.1.15. *repeatability*—consistency in successive measurements of the same quantity over time. It is a quantifier of the variability in measurement error.
- 3.1.16. *report interval*—the travel distance between the outputs of a profile *index* value.
- 3.1.17. *reproducibility*—the ability of two independent measurement systems to accurately, and with precision, measure and record a known or fixed value.
- 3.1.18. *roughness*—according to ASTM E 867, the deviation of a surface from a true planar surface with characteristic dimensions that affects vehicle dynamics and ride quality.
- 3.1.19. *running interval*—set travel distance that is stepped through a test segment by an increment shorter than its length.
- 3.1.20. *sample interval*—the longitudinal distance between data capture points. The data include location, height, and accelerometer values. These data points are combined to create one profile data point. These points may, in turn, be averaged to create a final value on the reported profile.
- 3.1.21. *sampling rate*—the rate at which the height sensor measures vertical displacement. A typical sample rate provides many height measurements from which a single value is derived for reporting at the sample interval.
- 3.1.22. *sensors*—devices that measure physical quantities. They are responsive to a change in a physical measurement such as distance, temperature, and acceleration.
- 3.1.23. *standoff distance*—the distance from the light source to a point in the center of the measurement range.
- 3.1.24. *transducer*—device that converts variables of one type (i.e., voltage) into those of another type (i.e., distance). These conversions must conform to a known transformation (i.e., proportional) to be useful.

4. GENERAL SYSTEM REQUIREMENTS

- 4.1. *General*—The IPS shall function independently from the vehicle suspension dynamics and vehicle speed within the operating range of 15–70 mph for high-speed profilers and 10–20 mph for low-speed profilers. The system shall be managed and the data collected by a computer system in conjunction with the necessary interface electronics.

Note 1—Due to system dynamics, profiles collected at low speeds may require a governor to keep the speed constant.