Designation: E1926 – 08 (Reapproved 2021)

Standard Practice for Computing International Roughness Index of Roads from Longitudinal Profile Measurements[1]

This standard is issued under the fixed designation E1926; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the mathematical processing of longitudinal profile measurements to produce a road roughness statistic called the International Roughness Index (IRI).

1.2 The intent is to provide a standard practice for computing and reporting an estimate of road roughness for highway pavements.

1.3 This practice is based on an algorithm developed in the International Road Roughness Experiment sponsored by a number of institutions including the World Bank and reported in two World Bank Technical Papers (**1**, **2**).[2] Additional technical information is provided in two Transportation Research Board (TRB) papers (**3**, **4**).

1.4 The values stated in SI units are to be regarded as the standard. The inch-pound units given in parentheses are for information only.

1.5 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

E177 Practice for Use of the Terms Precision and Bias in ASTM Test Methods

E867 Terminology Relating to Vehicle-Pavement Systems

E950/E950M Test Method for Measuring the Longitudinal Profile of Traveled Surfaces with an Accelerometer-Established Inertial Profiling Reference

E1082 Test Method for Measurement of Vehicular Response to Traveled Surface Roughness

E1170 Practices for Simulating Vehicular Response to Longitudinal Profiles of Traveled Surfaces

E1215 Specification for Trailers Used for Measuring Vehicular Response to Road Roughness

E1364 Test Method for Measuring Road Roughness by Static Level Method

E1656/E1656M Guide for Classification of Automated Pavement Condition Survey Equipment

E2133 Test Method for Using a Rolling Inclinometer to Measure Longitudinal and Transverse Profiles of a Traveled Surface

3. Terminology

3.1 *Definitions:*

3.1.1 Terminology used in this practice conforms to the definitions included in Terminology E867.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *International Roughness Index (IRI), n*—an index computed from a longitudinal profile measurement using a quarter-car simulation (see Practice E1170) at a simulation speed of 80 km/h (50 mph).

3.2.1.1 *Discussion*—IRI is reported in either metres per kilometre (m/km) or inches per mile (in./mile). (Note—1 m/km = 63.36 in./mile.)

3.2.2 *longitudinal profile measurement, n*—a series of elevation values taken at a constant interval along a wheel track.

3.2.2.1 *Discussion*—Elevation measurements may be taken statically, as with rod and level (see Test Method E1364) or inclinometer (see Test Method E2133), or dynamically, as with an inertial profiler (see Test Method E950/E950M).

3.2.3 *Mean Roughness Index (MRI), n*—the average of the IRI values for the right and left wheel tracks.

3.2.3.1 *Discussion*—Units are in metres per kilometre or inches per mile.

[1] This practice is under the jurisdiction of ASTM Committee E17 on Vehicle - Pavement Systems and is the direct responsibility of Subcommittee E17.33 on Methodology for Analyzing Pavement Roughness.

Current edition approved Feb. 1, 2021. Published February 2021. Originally approved in 1998. Last previous edition approved in 2015 as E1926 – 08 (2015). DOI: 10.1520/E1926-08R21.

[2] The boldface numbers given in parentheses refer to a list of references at the end of the text.

[3] 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.

3.2.4 *traveled surface roughness*—the deviations of a surface from a true planar surface with characteristics dimensions that affect vehicle dynamics, ride quality, dynamic loads, and drainage, for example, longitudinal profile, transverse profile, and cross slope.

3.2.5 *true International Roughness Index, n*—the value of IRI that would be computed for a longitudinal profile measurement with the constant interval approaching zero.

3.2.6 *wave number, n*—the inverse of wavelength.

3.2.6.1 *Discussion*—Wave number, sometimes called spatial frequency, typically has units of cycle/m or cycle/ft.

3.2.7 *wheel track, n*—a line or path followed by the tire of a road vehicle on a traveled surface.

4. Summary of Practice

4.1 The practice presented here was developed specifically for estimating road roughness from longitudinal profile measurements.

4.2 Longitudinal profile measurements for one wheel track are transformed mathematically by a computer program and accumulated to obtain the IRI. The profile must be represented as a series of elevation values taken at constant intervals along the wheel track.

4.3 The IRI scale starts at zero for a road with no roughness and covers positive numbers that increase in proportion to roughness. Fig. 1 associated typical IRI values with verbal descriptors from World Bank Technical Paper No. 46 (**2**) for roads with bituminous pavement, and Fig. 2 shows similar associations for roads with earth or gravel surfaces.

5. Significance and Use

5.1 This practice provides a means for obtaining a quantitative estimate of a pavement property defined as roughness using longitudinal profile measuring equipment.

5.1.1 The IRI is portable in that it can be obtained from longitudinal profiles obtained with a variety of instruments.

5.1.2 The IRI is stable with time because true IRI is based on the concept of a true longitudinal profile, rather than the physical properties of a particular type of instrument.

5.2 Roughness information is a useful input to the pavement management systems (PMS) maintained by transportation agencies.

5.2.1 The IRI for the right wheel track is the measurement of road surface roughness specified by the Federal Highway Administration (FHWA) as the input to their Highway Performance Monitoring System (HPMS).

5.2.2 When profiles are measured simultaneously for both traveled wheel tracks, then the MRI is considered to be a better measure of road surface roughness than the IRI for either wheel track.

NOTE 1—The MRI scale is identical to the IRI scale.

5.3 IRI can be interpreted as the output of an idealized response-type measuring system (see Test Method E1082 and Specification E1215), where the physical vehicle and instrumentation are replaced with a mathematical model. The units of slope correspond to accumulated suspension motions (for example, metres), divided by the distance traveled (for example, kilometres).

5.4 IRI is a useful calibration reference for response-type systems that estimate roughness by measuring vehicular response (see Test Method E1082 and Specification E1215).

5.5 IRI can also be interpreted as average absolute slope of the profile, filtered mathematically to modify the amplitudes associated with different wavelengths (**3**).

6. Longitudinal Profile Measurement

6.1 The longitudinal profile measurements can be obtained from equipment that operates in a range of speeds from static to highway traffic speeds.

6.2 The elevation profile measuring equipment used to collect the longitudinal profile data used in this practice must have sufficient accuracy to measure the longitudinal profile attributes that are essential to the computation of the IRI.

7. Computation of International Roughness Index (IRI)

7.1 This practice consists of the computation of IRI from an algorithm developed in the International Road Roughness Experiment and described in the World Bank Technical Papers 45 and 46 (**1**, **2**). Additional technical information provided in two TRB papers (**3**, **4**).

7.2 A Fortran version of this algorithm has been implemented as described in Ref (**3**).

7.2.1 This practice presents a sample computer program "IRISMP" for the computation of the IRI from the recorded longitudinal profile measurement.

7.2.1.1 The computer program IRISMP is a general computer program which accepts the elevation profile data set as input and then calculates the IRI values for that profile data set.

7.2.1.2 A listing of the IRISMP computer program for the computation of IRI is included in this practice as Appendix X2.

7.2.1.3 A provision has been made in the computer program listing (Appendix X2) for the computation of IRI from recorded longitudinal profile measurements in either SI or inch-pound units.

7.2.2 The input to the sample IRI computer program is an ASCII profile data set stored in a 1X,F8.3,1X,F8.3 Fortran format. In this format, the profile data appear as a multi-row, two column array with the left wheel path profile data points in Column 1 and the right wheel path points in Column 2. The profile data point interval is discretionary. However the quality of the IRI values computed by this algorithm is a function of the data point interval.

7.2.2.1 If the input to the IRI computer program is in SI units, the elevation profile data points are scaled in millimetres with the least significant digit being equal to 0.001 mm.

7.2.2.2 If the input to the IRI computer program is in inch-pound units, the elevation profile data points are scaled in inches with the least significant digit being equal to 0.001 in.

7.3 The distance interval over which the IRI is computed is discretionary, but shall be reported along with the IRI results.

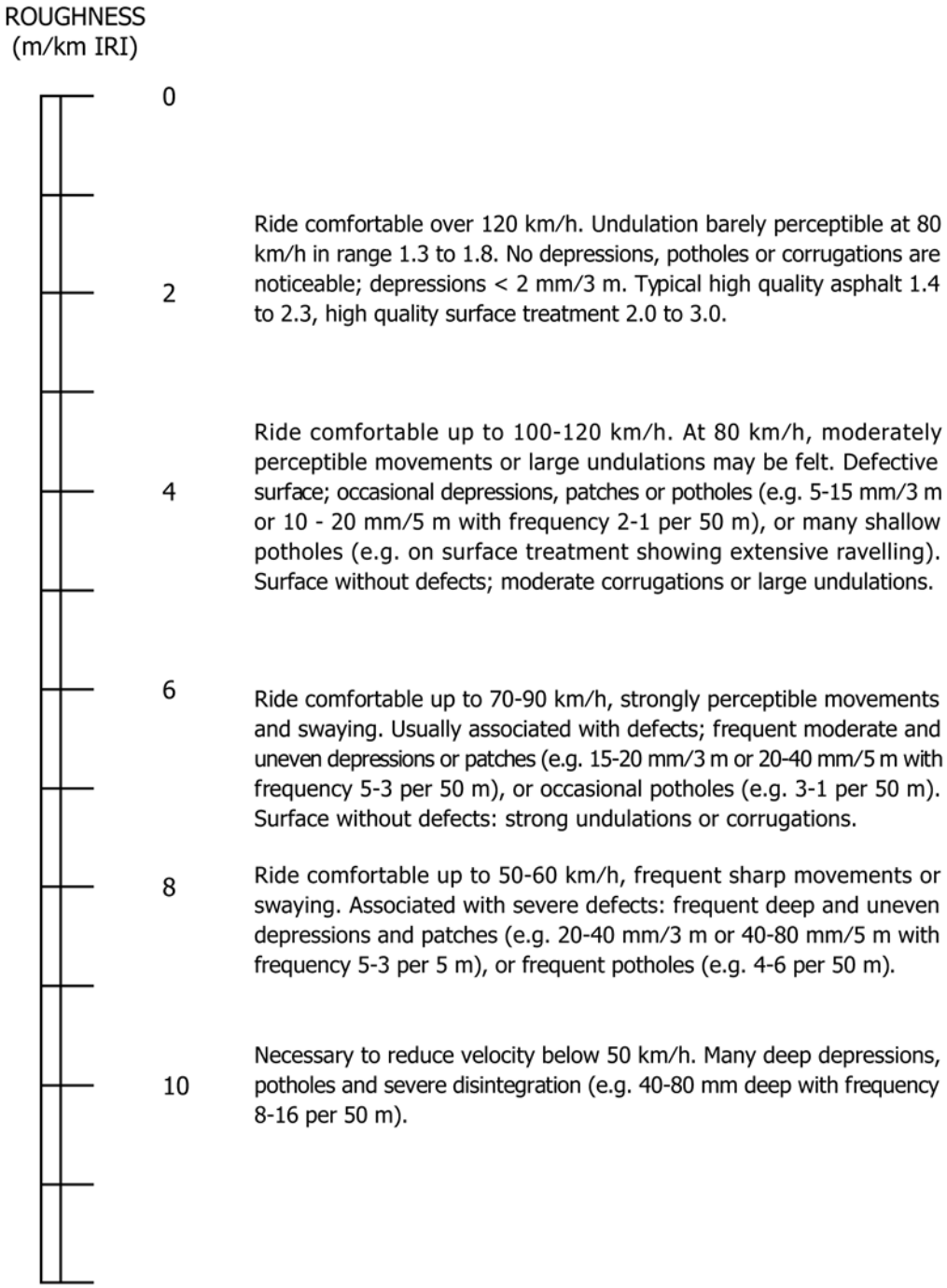

FIG. 1 Road Roughness Estimation Scale for Paved Roads with Asphaltic Concrete or Surface Treatment (Chipseal)

7.4 Validation of the IRI program is required when it is installed. Provision for the IRI program installation validation has been provided in this practice.

7.4.1 The sample profile data set TRIPULSE.ASC has been provided in SI units in Appendix X2 for validation of the computer program installation.

7.4.2 Using the sample profile data set TRIPULSE.ASC as input to the IRI computer program, an IRI value of 4.36 mm/m was computed for a profile data point interval of 0.15 m (0.5 ft) and a distance interval equal to 15 m of the profile data set in Appendix X2.

8. Report

8.1 Include the following information in the report for this practice:

8.1.1 *Profile Measuring Device*—The class of the profile measuring device used to make the profile measurement as defined in Test Method E950/E950M and Test Method E1364 shall be included in the report.

8.1.2 *Longitudinal Profile Measurements*—Report data from the profile measuring process shall include the date and time of day of the measurement, the location of the measurement, the