



Designation: E1364 – 95 (Reapproved 2023)

Standard Test Method for Measuring Road Roughness by Static Level Method¹

This standard is issued under the fixed designation E1364; 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 test method covers the measurement of a longitudinal profile of a travelled surface using a static level for the purpose of obtaining a road roughness index. This test method is suitable for all surface types that are travelled by conventional ground vehicles, including paved and unpaved roads.

1.2 This test method is labor intensive with respect to other means for measuring longitudinal profile, and is used mainly for (1) validating other profile measuring methods, and (2) calibrating response-type roughness measuring systems.

NOTE 1—When measuring road roughness with a static level for the purposes of validating other profile measuring methods or calibrating response-type roughness measuring systems, the static level measurement process should be evaluated to ensure the measurements are within the resolution required in Table 1. It is recommended that several locations be marked at various distances from the level and these locations be measured in sequence several times to establish if the readings stay within the resolution required. Wind, distance between the rod and the level, surface texture, and positioning of the rod all have significant impact on the repeatability of the elevation measurements. Any variation from the true elevations will primarily affect the bias as explained in 10.2. To determine the effect of random variations, random variations can be added to an existing profile and the IRI recalculated to determine the impact of the variations.

1.3 This test method describes the computation required for one particular type of roughness index, the vehicle simulation used in the International Roughness Index (IRI). Additionally, the profile obtained with this test method can be processed to obtain other roughness measures.

1.4 This test method includes two levels of accuracy that can be chosen according to need. The more accurate, designated as Class 1, reduces the measurement error of the roughness index to less than 2 % of the true value of the index. The second, designated as Class 2, involves errors less than 5 %.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical

conversions to SI units that are provided for information only and are not considered standard.

1.6 *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.*

1.7 *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:²

E950/E950M Test Method for Measuring the Longitudinal Profile of Traveled Surfaces

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

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

3. Summary of Test Method

3.1 Measures of surface elevation are obtained at constant intervals along a line on a travelled surface to define a longitudinal profile. The line used for the profile is called a wheeltrack, a path followed by the tire of a road vehicle. The measured numbers are recorded and entered into a computer for graphical display and analysis. The profile points are used as input to a computational algorithm that produces a summary roughness index.

3.2 This test method describes the use of conventional survey equipment comprising an optical level and graduated rod, but it may also be applied to automated techniques (for example, laser-based systems) with appropriate adjustments. At a minimum, two persons are required: one to locate and hold the rod (the rod-man), and a second to read relative

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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.

TABLE 1 Resolution Requirements

IRI Roughness Range, in./mile (m/km)	Required Resolution, in. (mm)	
	Class 1	Class 2
0 (0) ≤ IRI < 30 (.5)	0.005 (0.125)	0.01 (0.25)
30 (.5) ≤ IRI < 63 (1)	0.01 (0.25)	0.02 (0.5)
63 (1) ≤ IRI < 190 (3)	0.02 (0.5)	0.04 (1.0)
190 (3) ≤ IRI < 317 (5)	0.04 (1.0)	0.08 (2.0)
317 (5) ≤ IRI < 444 (7)	0.06 (1.5)	0.12 (3.0)
444 (7) ≤ IRI	0.08 (2.0)	0.16 (4.0)

heights through the leveling instrument and record the readings. For better efficiency, it is recommended that a third person record the readings to allow the instrument operator to concentrate on adjusting and reading the instrument. When maximum measuring speed is desired, a fourth crew member is recommended to act as relief.

4. Significance and Use

4.1 This test method provides a means for obtaining a standard roughness index using generic equipment. This particular test method is simple but labor intensive, and is most appropriate for establishing reference roughness levels for a limited number of test sites.

4.2 Test sites whose roughness is measured with this test method can be used to calibrate response-type measuring systems (see Test Method [E1082](#)).

4.3 Such sites can also be used to verify proper operation of other profile measuring systems, and to establish accuracy levels for other profile measuring systems (see Test Method [E950/E950M](#)).

5. Apparatus

5.1 *Tape*—A surveyor's tape is used to locate the elevation measures at constant intervals. The tape accuracy must be within 0.2 % of its total length. It is helpful to mark the locations at which the measures will occur if they are not clearly visible when the tape is laying on the ground (for example, mark 1 ft intervals with bright paint).

5.2 *Level*—The level must be designed to provide height readings with the required resolution. The resolution requirements are more stringent for smooth roads, and are summarized in [Table 1](#) based on IRI roughness levels. [Table 1](#) requires resolutions that are beyond the capabilities of most levels used in routine surveying and road construction. Precision leveling instruments used for extremely accurate control work or construction layout are required for measuring the roughness of most paved roads, which is typically in the range of 30 to 317 in./mile (0.5 to 5 m/km) IRI. With most precision instrumentation of this nature, the level and rod (see [5.3](#)) are calibrated together. Typically, the level includes a micrometer to interpolate between marks on the rod. Metric leveling instruments are available with a resolution of 0.1 mm, which is sufficient for any pavement. Class 1 precision is preferred when validating inertial profiling systems (see [8.3](#)). Class 2 precision is considered adequate for calibrating response-type systems.

NOTE 2—Survey equipment is available for measuring surface elevation

using a laser beam as a horizontal reference in lieu of a level. Such equipment may be used in accordance with the manufacturer's recommendations, as long as the resolution requirements from [Table 1](#) are met.

5.3 *Rod*—The rod must be marked such that changes in elevation between adjacent profile points can be discerned with the required precision. With most precision levels, the markings on the rod correspond to an interval built into a micrometer in the level (for example, 10 mm values are obtained visually from the rod, and 0.1 mm values are obtained from the micrometer).

NOTE 3—If a laser-based level is used, a suitable rod shall be used in accordance with the manufacturer's specifications. If the instrument does not require visible marks on the rod, such markings are not required. However, for any equipment used, the total system (instrument and rod) must have the resolution specified in [5.2](#).

5.3.1 The base of the rod should be designed to allow easily repeatable measures. On smooth-textured surfaces, almost any type of base is suitable. For use on textured surfaces, a circular pad with a diameter of at least 0.8 in. (20 mm) is suggested to reduce sensitivity of the measurement to small variations in the rod placement.

NOTE 4—In limited work performed to date, pads with diameters of 20 mm (0.8 in.) and 100 mm (4 in.) have been used successfully.

5.3.2 The absolute distance between the bottom of the rod and the markings is not relevant for roughness measurement. Therefore, temperature correction is not required. Also, modifications to the base of the rod are permitted (see [5.3.1](#)) to improve repeatability on textured surfaces.

5.3.3 A bubble level attached to the rod is recommended to aid in keeping the rod vertical.

5.4 *Computer*—Due to the potential for human error with the large amount of data obtained with this test method, all calculations shall be performed automatically by computer. The computer should have the capability to: (1) store all of the raw data values on a permanent medium (floppy disk, hard disk, magnetic tape, and so forth), (2) run programs that perform the calculations described in [8.2](#) and [8.3](#), and (3) graphically display the computed profile.

NOTE 5—Virtually all popular desktop and home computers have these capabilities.

NOTE 6—Virtually any computer language can be used to implement these tasks. Common choices are Fortran, BASIC, Pascal, and C. Also, spreadsheets and general-purpose numerical analysis programs can be used.

NOTE 7—Several computers can be employed for different tasks. For example, the profile computations could be performed on computer A, and displayed using computer B.

5.5 *Data Recording*—Instrument readings are typically recorded by writing the numbers on paper (field notes). Due to the large number of individual measurements involved in this test method, it is critical to eliminate as many sources of human error as possible. Standardized field forms should be used with longitudinal distances printed. The field forms should complement the display of the computer screen when the numbers are typed into the computer.