Designation: E1274 – 03 (Reapproved 2017)

# Standard Test Method for Measuring Pavement Roughness Using a Profilograph[1]

This standard is issued under the fixed designation E1274; 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 pavement roughness using an articulated multi-wheeled profilograph at least 23 ft (7 m) long (Fig. 1 is typical).

1.2 This test method utilizes a surface record made by moving the profilograph longitudinally over the pavement at less than 3 mph (5 km/hr). The record is analyzed to determine the rate of roughness and to identify bumps that exceed a specified threshold.

1.3 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.

1.4 *This standard does not purport to address all of the safety problems, 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.* See Section 6 for specific hazard statement.

1.5 *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 Adjuncts:*

Blueprint of California Profilograph Assembly (18 blueprints)[2]

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *blanking band*—a band of uniform height with its longitudinal center positioned optimally between the highs and lows of the surface record depicting at least 100 ft (30 m) of pavement (see Fig. 2).

3.1.2 *cutoff height*—a specified distance of a high on the surface record from a chord representing 25 ft (7.5 m) on the longitudinal scale. The chord may represent less than 25 ft (7.5 m) if it is from the lows on each side of the high (see Fig. 2).

3.1.3 *rate of roughness*—sum of the roughness divided by the longitudinal distance covered by the blanking band.

3.1.4 *roughness*—height of each continuous scallop rounded to the nearest 0.05 in. (1 mm), except those less than 0.03 in. (0.8 mm) vertically and 2 ft (0.6 m) longitudinally.

3.1.5 *scallops*—excursions of the surface record above and below the blanking band (see Fig. 2).

## 4. Significance and Use

4.1 This test method provides a means for measuring the roughness of new or rehabilitated pavements. Results may differ between profilographs of different designs and therefore will not necessarily agree with roughness measurements by other profilographs or other roughness-measuring equipment.

## 5. Apparatus

5.1 *Profilographs:*

5.1.1 *With Uniformly Spaced Wheels*—A reference platform comprised of dollies articulated by rigid members or trusses so that all the wheels are supporting the profilograph. There must be at least twelve reference platform wheels, and the axes of these wheels must be uniformly spaced throughout the effective length of the profilograph.[3] The effective length must be at least 23 ft (7 m) long. A surface sensing wheel and recorder shall be located at the center of the reference platform. The diameter of the surface sensing wheel shall be at least 6 in. (150 mm). If the recorder is graphic, its scales shall be 1:1 vertically and 1:300 longitudinally (1 in. = 25 ft). If the recorder is digital (optional analog display must have the same scales as the graphic recorder), it must sample 5 times/longitudinal inch of travel and record the relative height of the surface to at least the nearest 0.01 in. (0.25 mm).

[1] This test method is under the jurisdiction of ASTM Committee E17 on Vehicle - Pavement Systems and is the direct responsibility of Subcommittee E17.31 on Methods for Measuring Profile and Roughness.

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[2] Available from ASTM International Headquarters. Order Adjunct No. ADJE1274.

[3] Hankins, Kenneth D., "Construction Control Profilograph Principles," *Research Report 49-1*, Texas Highway Department, June 1967.

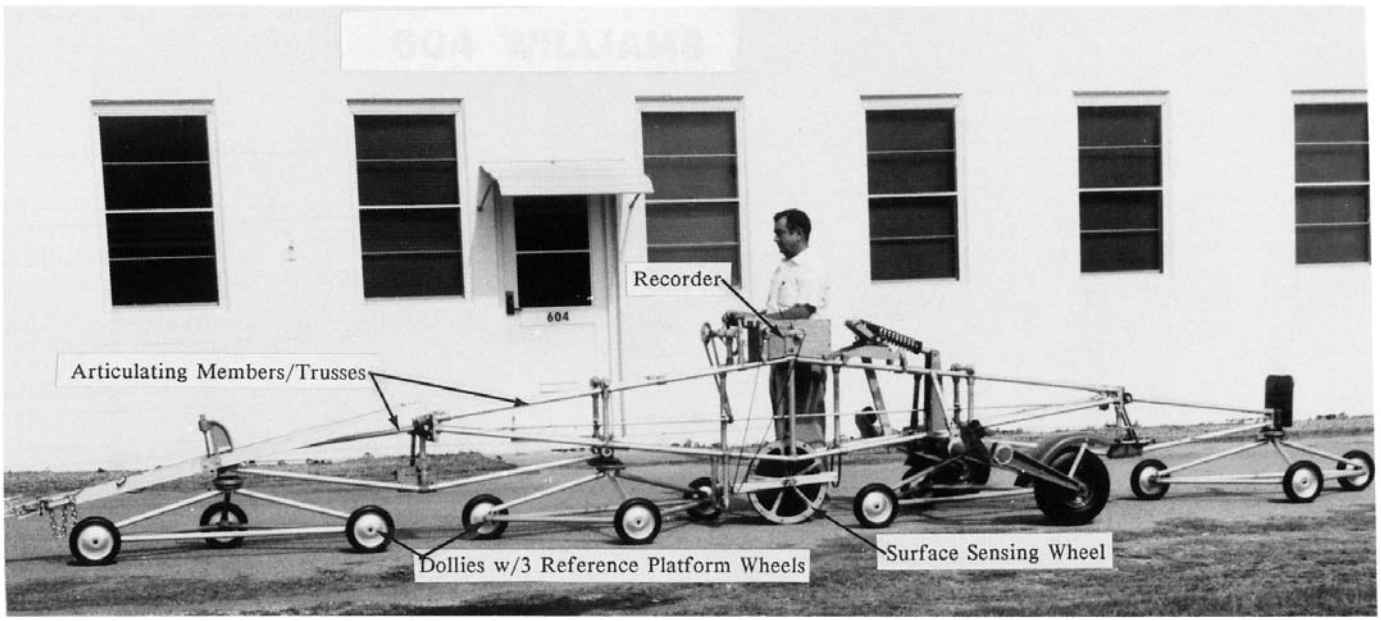
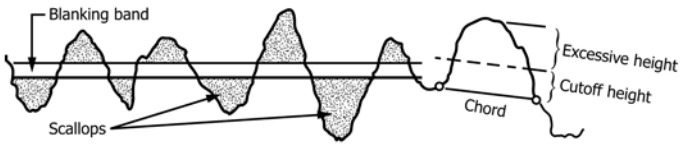



**FIG. 1 Typical Profilograph**




NOTE 1—Fig. 2 is graphic for visual reading. It can be digital for computer input.

**FIG. 2 Surface Record**

5.1.2 *With Non-Uniformly Spaced Wheels*—It shall be as described in 5.1.1, except the axes of the reference-platform wheels are not uniformly spaced but are at least 1 ft (0.3 m) apart so no two wheels cross the same bump at the same time. The recorder can be located elsewhere, but surface sensing equipment must be located at the center of the reference platform. A common apparatus with non-uniformly spaced wheels is the California profilograph (see 2.1).

5.1.3 There are differences in frequency responses between profilographs with uniformly spaced wheels and profilographs with non-uniformly spaced wheels (see Fig. 3).

5.2 *Blanking Band Template* (optional)—Approximately 2-in. (50-mm) wide clear plastic strip at least 4 in. (100 mm) long. A common length is 21.12 in. The center of the template is marked with an opaque strip the width of the stipulated blanking band throughout its length and with lines every 0.1 in. (2 mm) above and below the blanking band.

5.3 *Excessive Height Template* (optional)—Clear plastic piece marked with a 1.00 ± 0.02-in. (25.0 ± 0.5-mm) line that is the stipulated cutoff height distance from a straight edge on the template. Two small holes may be drilled to fix the ends of the line (see Fig. 2).

## 6. Hazards

6.1 Since profilographs in the testing mode are moved no faster than 3 mph (5 km/hr), do not operate near traffic without proper traffic control devices and use procedures that assure the safety of testing personnel and the public.

## 7. Sampling

7.1 Take profilograph recordings 3.5 ± 0.5 ft (1.0 ± 0.2 m) from and parallel to both edges of the pavement and to both sides of each planned longitudinal joint or in each planned wheel path.

7.2 Any exceptions to these sampling requirements (for example, 25 ft from each bridge) must be stipulated.

## 8. Calibration

8.1 *Height Recording:*

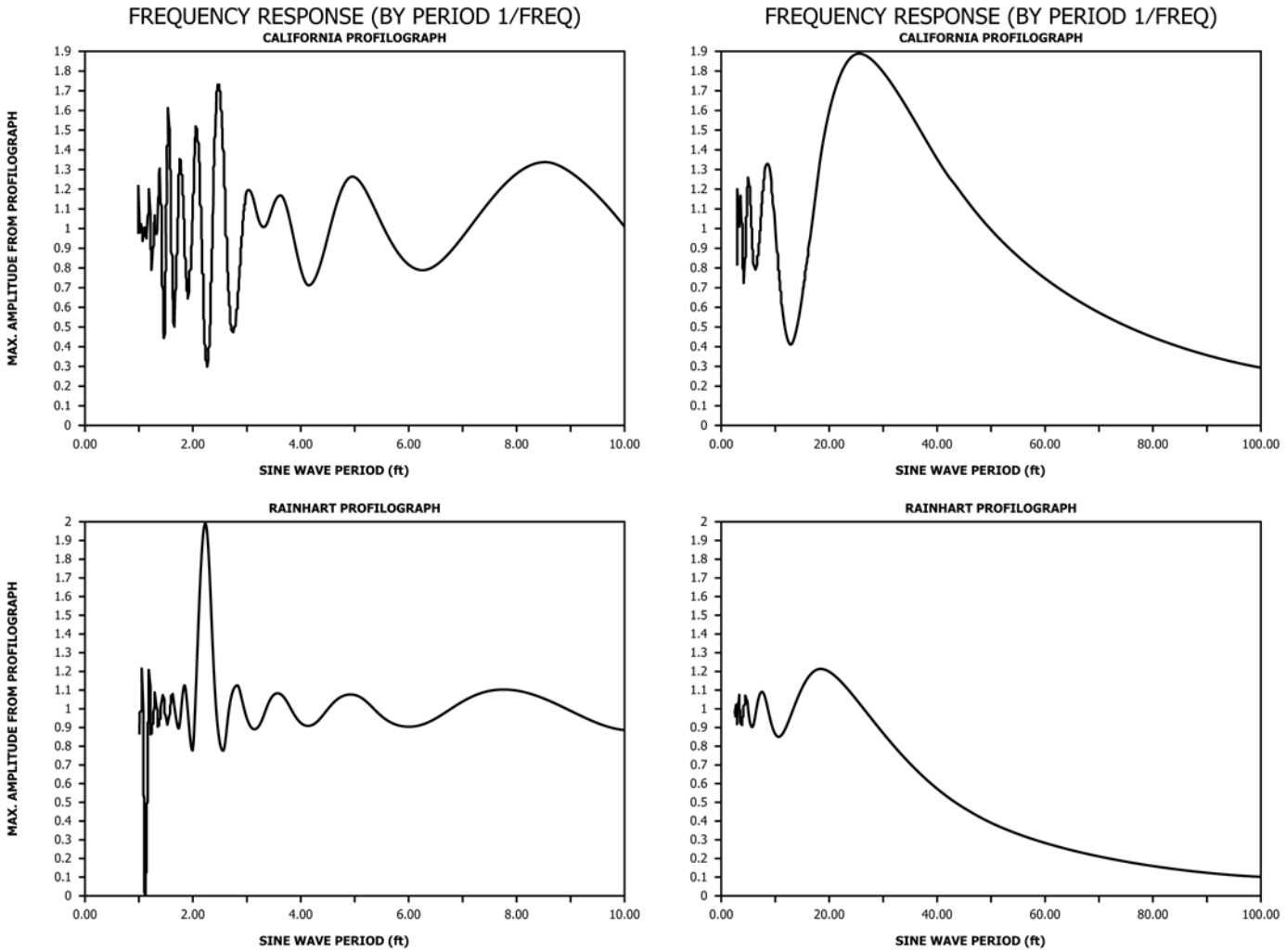
8.1.1 Place gauge blocks of 0.5 in. (10 mm) and 1.5 in. (60 mm) under the surface sensing wheel. The record must indicate the actual height of each platform within ±0.02 in. (0.5 mm).

8.1.2 Verify the standardization of the height recording before any week of use, whenever the profilograph is re-assembled and whenever there is evidence of possible inaccuracy.

8.2 *Distance Recording:*

8.2.1 Mark a distance of 100.00 ft (30.00 m) on reasonably even pavement. Move the profilograph forward until a particular point is at the first mark and make the recorder mark the event on the record. Move the profilograph forward again until the point is at the second mark and make the recorder to mark this event, too. The record must indicate 100 ± 1 ft (30.0 ± 0.3 m) between the two events (4.00 ± 0.04 in. on graphic record).

8.2.2 Verify the standardization of the distance recording before any month of use and whenever there is evidence of possible inaccuracy.




NOTE 1—This figure comes from Walker, Roger S., and H.-T. Lin, The University of Texas at Arlington, Research Project 8-10-87-569, "Correlation of California and Rainhart Profilographs with PSI," conducted for Texas State Department of Highways and Public Transportation in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

**FIG. 3 Computer Simulation of Profilograph Responses to Sinusoidal Inputs of Different Periods (wave lengths)**

## 9. Procedure

9.1 Clear the intended profilograph path of all loose material and foreign objects.

9.2 If possible, move the profilograph about 30 ft (10 m) forward to the starting point. Once there, initialize the recorder and make beginning notations.

9.3 Move the profilograph forward no faster than 3 mph (5 km⁄hr), steering it to stay within that prescribed sampling path. Pertinent observation about surveyed location or unusual conditions may be made on the record only as they occur. Observe the recorder for any unusual operation.

9.4 Upon completion of a sampling path, make ending notations and review the recording for reasonableness. Repeat the procedure for successive sampling paths.

## 10. Calculation

NOTE 1—Calculations can be done manually with the blanking band and excessive height templates or electronically with routines in a computer.

10.1 Apply the blanking band to successive lengths of the surface record. Determine the roughness from each scallop. Add all roughness for each stipulated segment. From the surface record, determine the longitudinal distance between the farthest points of the beginning and ending scallops or absence thereof. Divide the result of the addition by the corresponding longitudinal distance to calculate the rate of roughness for that segment of that path.

10.2 Apply the excessive height chord to the top of each wave on the surface record. Identify all bumps that are excessively high by their locations.

## 11. Report

11.1 The following information shall be given for each specific application:

11.1.1 Height of blanking band to nearest 0.05 in. (1 mm), (for example, 0.1 or 0.2 in.),

11.1.2 Cutoff height to the nearest 0.05 in. (1 mm), (for example, 0.3 in.),

11.1.3 Profilograph with or without uniformly spaced reference platform wheels, and

11.1.4 Length of each segment for which the rate of roughness is calculated.

## 12. Precision and Bias

12.1 The precision and bias of this test method are being determined.

## 13. Keywords

13.1 graphic surface record; pavement; roughness