Designation: E 965 – 96 (Reapproved 2001)

Standard Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique[1]

This standard is issued under the fixed designation E 965; 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 describes a procedure for determining the average depth of pavement surface macrotexture (see 3.1) **(1)**[2] by careful application of a known volume of material on the surface and subsequent measurement of the total area covered. The technique is designed to provide an average depth value of only the pavement macrotexture and is considered insensitive to pavement microtexture characteristics.

1.2 The results obtained using this procedure to determine average pavement macrotexture depths do not necessarily agree or correlate directly with those obtained by other pavement macrotexture measuring methods **(1-5).**

1.3 The values stated in inch-pound units are to be regarded as the standard.

1.4 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 1155 Test Method for Roundness of Glass Spheres[3]

E 178 Practice for Dealing with Outlying Observations[4]

E 867 Terminology Relating to Vehicle-Pavement Systems[5]

3. Terminology

3.1 Terminology used in this standard conforms to Terminology E 867.

3.2 *Definition of Term Specific to This Standard:*

3.2.1 *pavement macrotexture*—the deviations of a pavement surface from a true planar surface with the characteristic dimensions of wavelength and amplitude from 0.5 mm up to those that no longer affect tire-pavement interaction.

4. Summary of Test Method

4.1 The standard materials and test apparatus consist of a quantity of uniform material, a container of known volume, a suitable wind screen or shield, brushes for cleaning the pavement surface, a flat disk for spreading the material on the surface, and a ruler or other measuring device for determining the area covered by the material. A laboratory balance is also recommended for further ensuring consistent amounts for each measurement sample.

4.2 The test procedure involves spreading a known volume of material on a clean and dry pavement surface, measuring the area covered, and subsequently calculating the average depth between the bottom of the pavement surface voids and the tops of surface aggregate particles. This measurement of pavement surface texture depth reflects the pavement macrotexture characteristics **(1, 5).**

NOTE 1—In spreading the material specified in this test method, the surface voids are completely filled flush to the tips of the surrounding aggregate particles. This test method is not considered suitable for use on grooved surfaces or pavements with large (≥1.0 in. (25 mm)) surface voids.

5. Significance and Use

5.1 This test method is suitable for field tests to determine the average macrotexture depth of a pavement surface. The knowledge of pavement macrotexture depth serves as a tool in characterizing the pavement surface texture. When used in conjunction with other physical tests, the macrotexture depth values derived from this test method may be used to determine the pavement skid resistance capability and the suitability of paving materials or finishing techniques. When used with other tests, care should be taken that all tests are applied at the same location. Improvements in pavement finishing practices and maintenance schedules may result from use of this test method.

5.2 The texture depth measurements produced using this test method are influenced by pavement macrotexture characteristics and not significantly affected by pavement microtexture. Pavement aggregate particle shape, size, and distribution are texture features not addressed in this procedure. This test method is not meant to provide a complete assessment of pavement surface texture characteristics.

5.3 The pavement macrotexture depth values measured by this test method, with the equipment and procedures stated

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[1] This test method is under the jurisdiction of ASTM Committee E17 on Vehicle-Pavement Systems and is the direct responsibility of Subcommittee E17.23 on Surface Characteristics Related to Tire–Pavement Slip Resistance.

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[2] The boldface numbers in parentheses refer to the list of references at the end of this test method.

[3] *Annual Book of ASTM Standards*, Vol 06.02.

[4] *Annual Book of ASTM Standards*, Vol 14.02.

[5] *Annual Book of ASTM Standards*, Vol 04.03.

herein, do not necessarily agree or correlate directly with other techniques of surface texture measurements. This test method is also suitable for research and development purposes, where direct comparisons between pavement surfaces are to be made within the same test program.

NOTE 2—The pavement surface to be measured using this test method must be dry and free of any construction residue, surface debris, and loose aggregate particles that would be displaced or removed during normal environmental and traffic conditions.

6. Materials and Apparatus

6.1 The essential elements of the apparatus, shown in Fig. 1, consist of the following material and equipment:

6.1.1 *Material*[6]—Solid glass spheres having 90 % roundness in accordance with Test Method D 1155. The spheres shall be graded to have a minimum of 90 % by weight passing a No. 60 sieve and retained on a No. 80 sieve[7].

6.1.2 *Sample Container*—A cylindrical metal or plastic container with a predetermined internal volume of at least 1.5 cubic in. (25 000 mm^3) shall be used to determine the volume of sand spread.

6.1.3 *Spreader Tool*—A flat, hard disc approximately 1 in. (25 mm) thick and 2.5 to 3.0 in. (60 to 75 mm) in diameter shall be used to spread the sand. The bottom surface or face of the disc shall be covered with a hard rubber material and a suitable handle may be attached to the top surface of the disc.

NOTE 3—An ice hockey puck is considered suitable for use as the hard rubber material in this test method.

6.1.4 *Brushes*—A stiff wire brush and a soft bristle brush shall be used to clean thoroughly the pavement surface prior to application of the material sample.

[6] Historically Ottawa natural silica sand was used for this test method. Glass spheres have been found to provide an equivalent measurement but with greater precision, both within laboratory and between laboratories. An additional motivation to use glass spheres is the difficulty of preparing Ottawa sand meeting the gradation requirements of passing a No. 50 sieve and retained on a No. 100 sieve. Manual sieving is necessary and is time consuming producing low yields of usable material from most sources of sand. However, when sand meeting the gradation requirements is used, the resulting texture depth approximates that obtained with glass spheres.

[7] Commercially available material may be used, but must be graded and tested for roundness to assure that they conform to this test method.

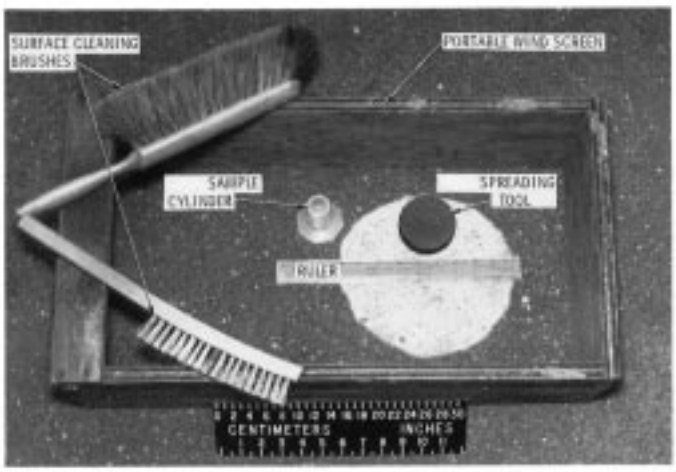

FIG. 1 Apparatus for Measuring Surface Macrotexture Depth

6.1.5 *Wind Screen*—A suitable screen or shield shall be placed on the pavement surface to protect the material sample from the wind and turbulence created by traffic. An example is shown in Fig. 1.

6.1.6 *Scale*—A standard scale 12 in. (305-mm) or greater in length and having 0.1-in. (2.5-mm) or 1-mm (0.04-in.) divisions should be used.

6.2 Use of a laboratory balance, sensitive to 0.1 g, is recommended with this test method to provide additional control and to ensure that the amount of material used for each surface macrotexture depth measurement is equal in both mass and volume.

7. Procedure

7.1 *Test Area*—Inspect the pavement surface to be measured and select a dry, homogeneous area that contains no unique, localized features such as cracks and joints. Thoroughly clean the surface using the stiff wire brush first and subsequently the soft bristle brush to remove any residue, debris, or loosely bonded aggregate particles from the surface. Position the portable wind screen around the surface test area.

7.2 *Material Sample*—Fill the cylinder of known volume with dry material and gently tap the base of the cylinder several times on a rigid surface. Add more material to fill the cylinder to the top, and level with a straightedge. If a laboratory balance is available, determine the mass of material in the cylinder and use this mass of material sample for each measurement.

7.3 *Test Measurement*—Pour the measured volume or weight of material onto the cleaned surface within the area protected by the wind screen. Carefully spread the material into a circular patch with the disk tool, rubber-covered side down, filling the surface voids flush with the aggregate particle tips. Measure and record the diameter of the circular area covered by the material at a minimum of four equally spaced locations around the sample circumference. Compute and record the average diameter.

NOTE 4—For very smooth pavement surfaces where the patch diameters are greater than 12 in. (305 mm), it is recommended that half the normal volume of material be used.

7.4 *Number of Test Measurements*—The same operator should perform at least four, randomly-spaced measurements of average macrotexture depth on a given test pavement surface type. The arithmetic average of the individual macrotexture depth values shall be considered to be the average macrotexture depth of the test pavement surface.

8. Calculation

8.1 *Cylinder Volume*—Calculate the internal volume of the sample cylinder as follows:

$$V = \frac{\pi d^2 h}{4} \quad (1)$$

where:

V = internal cylinder volume, $in.^3$(mm^3),
d = internal cylinder diameter, in. (mm), and
h = cylinder height, in. (mm).

8.2 *Average Pavement Macrotexture Depth*—Calculate the average pavement macrotexture depth using the following equation:

$$MTD = \frac{4V}{\pi D^2} \quad (2)$$

where:

MTD = mean texture depth of pavement macrotexture, in. (mm),
V = sample volume, in.^{3}(mm^3), and
D = average diameter of the area covered by the material, in. (mm).

9. Faulty Tests

9.1 Tests that are manifestly faulty or that give mean texture depth values differing by more than 0.005 in. (0.13 mm) from the average of all tests on the same pavement surface shall be treated in accordance with Practice E 178.

10. Report

10.1 The report for each pavement test surface shall contain data on the following items:

10.1.1 Location and identification of test pavement surface,

10.1.2 Date,

10.1.3 Volume of material used for each test measurement, in.^{3}(mm^3),

10.1.4 Number of test measurements,

10.1.5 Average diameter of the area covered by the material, in. (mm), for each test,

10.1.6 Mean texture depth, in. (mm), for each test, and

10.1.7 Mean texture depth, in. (mm), for total pavement test surface.

11. Precision and Bias

11.1 Analysis of macrotexture depth data collected during extensively controlled tests[8] produced estimates of the repeatability (method precision) and reproducibility (applied precision) of the volumetric method, as well as sampling errors that can be expected in measuring the average texture depths of a pavement section by the method. The controlled tests were conducted on laboratory specimens having a range of macrotexture depth of 0.02 to 0.047 in. (0.508 − 1.2 mm). The macrotexture depth precision estimates are expressed as a percentage, such as the ratio of the standard deviation of the texture measurements to the mean texture depth multiplied by 100.

11.2 The standard deviation of the repeated measurements by the same operator on the same surface can be as low as 1 % of the average texture depth.

11.3 The standard deviation of the repeated measurements by different operators on the surface can be as low as 2 % of the average texture depth.

NOTE 5—The standard deviation of the site-to-site measurements may be as large as 27 % of the average texture depth. Here site defines a randomly selected location within a nominally homogeneous pavement section. This means that a large number of measurement observations would be necessary to estimate the average texture depth reliably for given pavement types with large variations in texture, despite the fact that the method is highly repeatable and not subject to large operational influences.

[8] Supporting data are available from ASTM Headquarters Request Research Report: RR:E17-1001.

REFERENCES

(**1**) Yager, T. J., and Buhlmann, F., "Macrotexture and Drainage Measurements on a Variety of Concrete and Asphalt Surfaces," *ASTM STP 763*, ASTM, 1982.

(**2**) American Concrete Paving Association, "Guideline for Texturing of Portland Cement Concrete Highway Pavements," *Technical Bulletin No. 19*, March 1975.

(**3**) Hegmon, R. R., and Mizoguchi, M.," Pavement Texture Measurement by the Sand Patch and Outflow Meter Methods," *Automotive Safety Research Program, Report No. S40, Study No. 67-11*, Pennsylvania State University, January 1970.

(**4**) Dahir, S. H., and Lentz, H. J., "Laboratory Evaluation of Pavement Surface Texture Characteristics in Relation to Skid Resistance," *Federal Highway Administration Report No. FHWA-RD-75-60*, June 1972.

(**5**) Rose, J. G. et al., "Summary and Analysis of the Attributes of Methods of Surface Texture Measurements," *ASTM STP 53*, ASTM, June 1972.