Designation: E 2157 – 01

Standard Test Method for Measuring Pavement Macrotexture Properties Using the Circular Track Meter[1]

This standard is issued under the fixed designation E 2157; 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 procedure for obtaining and analyzing pavement macrotexture profiles using the Circular Track Meter (CTMeter).

1.2 The CTMeter consists of a charge coupled device (CCD) laser– displacement sensor which is mounted on an arm that rotates such that the displacement sensor follows a circular track having a diameter of 284 mm (11.2 in.).

1.3 The CTMeter is designed to measure the same circular track that is measured by the Dynamic Friction Tester (DFTester).

1.4 The CTMeter can be used both for laboratory investigations and in the field on actual paved surfaces.

1.5 The software developed for the CTMeter reports the Mean Profile Depth (MPD) and the Root Mean Square (RMS) values of the macrotexture profiles.

1.6 The values stated in SI (metric) units are to be regarded as standard. The inch-pound equivalents are rationalized, rather than exact mathematical conversions.

1.7 *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:*

E 867 Terminology Relating to Vehicle-Pavement Systems[2]

E 1845 Practice for Calculating Pavement Macrotexture Mean Profile Depth[2]

E 1911 Test Method for Measuring Paved Surface Frictional Properties Using the Dynamic Friction Tester[2]

2.2 *Other Document:*

Manufacturer's "Operating Manual for the Circular Texture Meter," Sunny Koken Company, 3-8-4 Shinsayama, Sayama-shi, Saitama-ken, Japan 1331

3. Terminology

3.1 See Terminology E 867.

3.2 *Definitions:*

3.2.1 *negative texture*—Macrotexture produced by depressions in the surface.

3.2.2 *positive texture*—Macrotexture produced by asperities projecting above the surface.

4. Summary of Test Method

4.1 This method utilizes a displacement sensor that is mounted on an arm that rotates clockwise at a fixed elevation from the surface being measured. The sensor is attached to the arm at a radius of 142 mm (5.6 in.).

4.2 The device is controlled by a notebook computer which saves and processes the data. When the measurement is initiated by the computer, a DC motor drives the arm for a full 360° revolution.

4.3 The profile is recorded in the computer memory and is divided into eight segments for analysis (See Fig. 1). The computer software can process the data to report either the MPD in accordance with Practice E 1845 or the RMS or both for each segment.

5. Significance and Use

5.1 In the PIARC International Experiment (**1**[3]) it was found that the volumetric mean texture depth (MTD) was highly correlated to the speed constant of the International Friction Index. It has been found that the average of the MPD values for the eight segments using the CTMeter is extremely highly correlated with the MTD and can replace the volumetric measurement for determination of the MTD (**2**). The recommended relationship for the estimate of the MTD from the MPD by the CTMeter is:

$$MTD = 0.947\ MPD + 0.069 \quad (1)$$

when MTD and MPD are expressed in millimetres, or:

$$MTD = 0.947\ MPD + 0.0027 \quad (2)$$

when MTD and MPD are expressed in inches.

NOTE 1—These equations differ from those given in Practice E 1845, which are for the estimated texture depths from linear profiles.

5.2 Comparison of the MPD and the RMS for a surface provides information of the nature of the texture, that is,

[1] This test method is under the jurisdiction of ASTM Committee E17 on Vehicle-Pavement Systems and is the direct responsibility of Subcommittee E17.21 on Field Methods for Measuring Tire Pavement Friction.

Current edition approved Aug.10, 2001. Published October 2001.

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

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

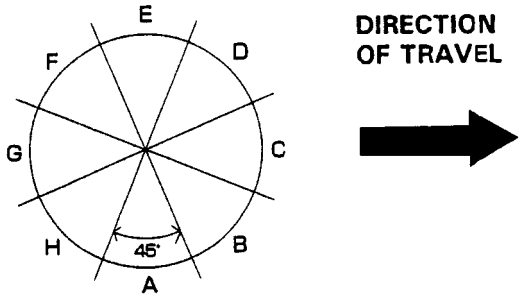

FIG. 1 Segments of the Circular Track Profile

whether the texture is positive or negative (**3**).

5.3 Analysis of the individual segments can be performed to examine the profile parallel to the direction of travel (segments A and E) and perpendicular to the direction of travel (segments C and G). This information could be particularly useful in the study of surfaces that have texture with significant directional characteristics.

6. Apparatus

6.1 *CTMeter*—The measuring instrument consists of a CCD laser-displacement sensor mounted on an arm that rotates at 80 mm (3.15 in.) above the surface on a diameter of 284 mm (11.18 in.). The arm is driven by a DC motor at a tangential velocity of 6 m/min (19.7 ft/min) in a counterclockwise direction.

6.2 *Data Collection*—The CCD is sampled 1024 times per revolution providing a sample spacing on 0.87 mm (0.034 in.) by an A/D converter.

6.3 *Data Recording*—The data are recorded in memory in a notebook computer. The data are segmented into eight 111.5 mm (4.39 in.) arcs of 128 samples each. The computer software computes the MPD, the RMS, or both, of each segment.

6.4 *Displacement Sensor*—The CCD laser-displacement sensor shall have a spot size of 70 µm (2.76×10^{-3} in.) over a range of 65 to 90 mm (2.56 to 3.54 in.). The vertical resolution shall be 3 µm ($.12 \times 10^{-3}$ in.).

7. Test Samples

7.1 *Field*—Field test surfaces shall be free of loose particles. The test surface does not have to be horizontal provided the instrument can be leveled in working position.

7.2 *Laboratory*—Laboratory test panels shall be clean and free of loose particles and shall be held firmly during measurement.

7.2.1 Flat laboratory test panels shall have a test surface of at least 600 by 600 mm (24 by 24 in.) with no disturbance from edge effects for a diameter of 500 mm (20 in.).

8. Calibration

NOTE 2—*Manufacturer's Calibration:* The CTMeter shall be calibrated at the manufacturer's facility, using a precision machined calibration surface having a sawtooth profile having an amplitude of 7 mm (0.28 in) and a period of 28 mm (1.10 in), producing an MPD of 3.5 mm (0.14 in).

8.1 *Field Calibration*—Prior to each measurement session, the CTMeter shall be checked using the calibration panel provided by the manufacturer. The result shall be within ±0.05 mm (0.002 in.) of the value indicated on the panel. If the result is outside these limits, the CTMeter shall be returned to the manufacturer for calibration.

9. Procedure

9.1 Place the CTMeter on the test surface which should be free of any contamination. If the measurement is to be used in conjunction with a measurement by the Dynamic Friction Tester (DFTester) specified in Test Method E 1911, the location should be marked such that the DFTester can be placed in the same location.

NOTE 3—It is preferable to operate the CTMeter at a location where the surface is flat. However, it has been shown that the effect is negligible for a deviation from flatness of up to 6 mm (0.24 in.) over a 0.5 m (20 in.) specimen.

9.2 Orient the CTMeter with the segments C and G perpendicular to the direction of travel as shown in Fig. 1.

NOTE 4—If there is no predominant travel direction, position the CTMeter in an identifiable orientation, such as a physical characteristic of the site or according to compass direction.

9.3 Select the option to compute the MPD, the RMS, or both, of the profiles and initiate the measurement from the notebook computer.

9.4 Record the test results or store the data for future analysis.

10. Report

10.1 The report shall include the following:

10.1.1 Date and time of day,

10.1.2 Individual values of the friction MPD, RMS, or both, for each of the eight segments and the average value of the eight segments,

10.1.3 Temperature of the test surface,

10.1.4 Type, age, condition, and location of test surface,

10.1.5 Plot of the profile,

10.1.6 Type and date of the most recent calibration.

11. Precision and Bias

11.1 *Precision*—The standard deviation of eight measurements on the same test surface is 0.03 mm (0.001 in.).

11.2 *Bias*—There is no basis for determination of the bias.

12. Keywords

12.1 pavement texture; skid resistance

APPENDIX

(Nonmandatory Information)

X1. DIMENSIONS OF THE CIRCULAR TRACK TMETER

Fig. X1.1 depicts the dimensions of the CTMeter.

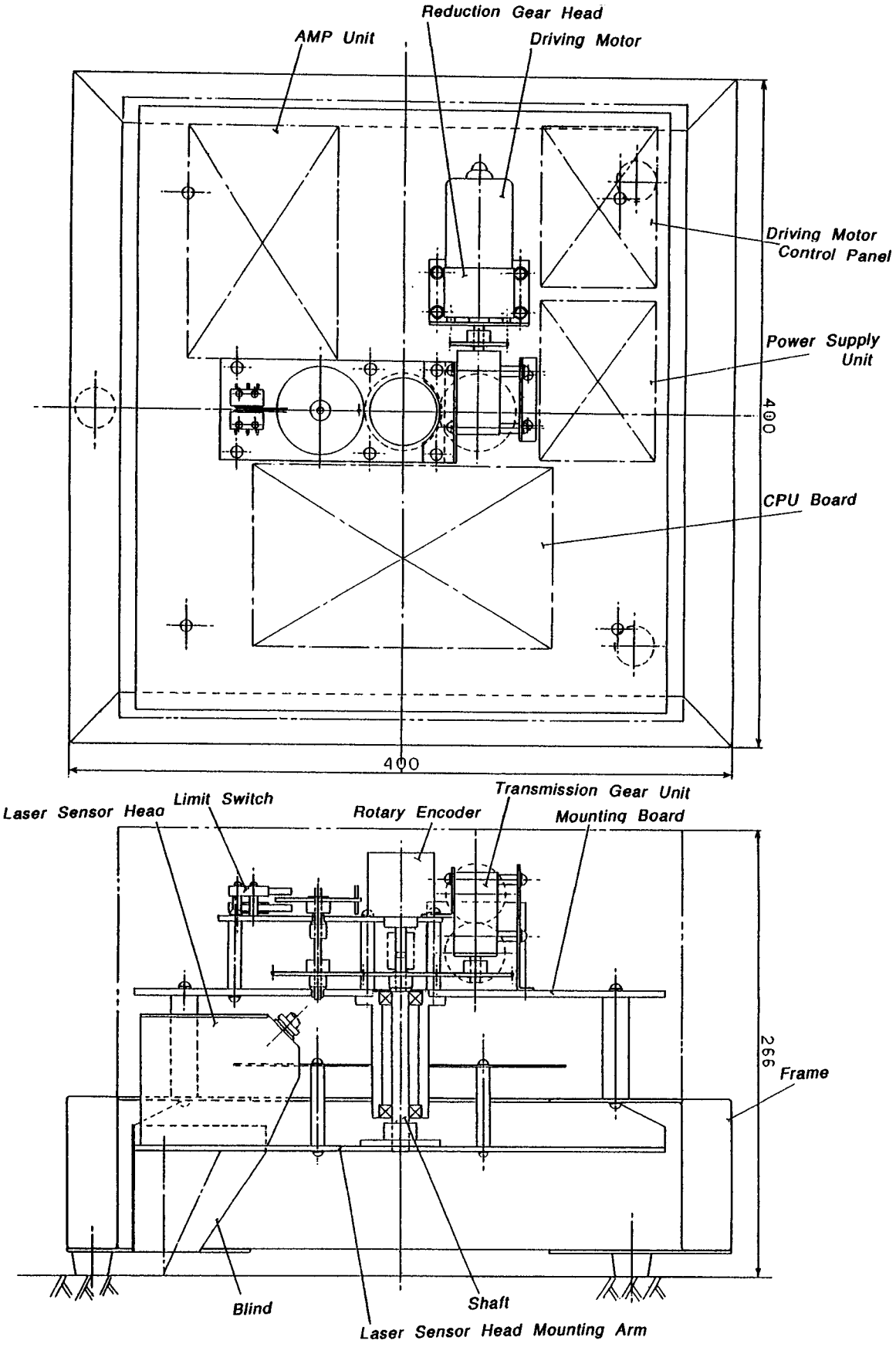

FIG. X1.1 Dimensions of the CT Meter

REFERENCES

(**1**) Wambold, J. C., Antle, C. E., Henry, J. J., and Rado, Z., "International PIARC Experiment to Compare and Harmonize Texture and Skid Resistance Measurements, Final report," *Permanent International Association of Road Congresses (PIARC)*, Paris, 1995.

(**2**) Abe, H., Henry, J.J., Tamai, A., and Wambold, J.C., "Measurement of Pavement Macrotexture Using the Circular Texture Meter (CTMeter)," *Transportation Research Board Annual Meeting*, Washington DC, 2001.

(**3**) Wennink, M. and Gerritsen, W., "Detection of Changes of Pavement Texture Material Recognition," *Proceedings of the Fourth International Symposium on Pavement Surface Characteristics*, Nantes, 2000.