Standard Test Method for Measuring Pavement Texture Drainage Using an Outflow Meter[1]

1. Scope

1.1 This test method covers the connectivity of the texture as it relates to the drainage capability of the pavement through its surface and subsurface voids. This is a specific device that times how long it takes a known quantity of water, under gravitational pull, to escape through voids in the pavement texture of the structure being tested. The technique is intended to provide a measure of the ability of the pavement to relieve pressure from the face of vehicular tires and thus an indication of hydroplaning potential under wet conditions. A faster escape time indicates a thinner film of water may exist between the tire and the pavement, thus more micro-texture could be exposed to indent the face of the tire and more surface friction available to the tire. The lower the number of seconds it takes to evacuate the water, the lower the water pressure under the tire. It will be up to the operator to compare the results of this test to other pertinent factors such as expected rainfall intensity and frequency, aggregate type, consistency of texture, grade, slope, expected vehicular speed, and accident history, to determine the relationship between the outflow meter reading and the likelihood of hydroplaning on a given surface. Comparing the outflow meter reading of a pavement known to have a history of hydroplaning, against one with a good history, with all other factors similar, will give the operator an indication of the outflow meter number that will be necessary to promote wet weather safety.

1.2 The results obtained using this test method are related to the mean hydraulic radius of a paved surface and may correlate with other methods to measure texture.

1.3 The results obtained using this test method are related to the mean texture depth (MTD).

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E178 Practice for Dealing With Outlying Observations
E867 Terminology Relating to Vehicle-Pavement Systems
E965 Test Method for Measuring Pavement Macrotexture Depth Using a Volumetric Technique (Withdrawn 2015)[3]
E1845 Practice for Calculating Pavement Macrotexture Mean Profile Depth
E2157 Test Method for Measuring Pavement Macrotexture Properties Using the Circular Track Meter

3. Terminology

3.1 For definitions of terms, see Terminology E867.

4. Summary of Test Method Operations

4.1 The main body of the outflow meter is a vertical cylinder for containing water. It has an open top and a rubber ring mounted centrally around an orifice or opening on the bottom of the device to form a seal against the pavement surface. Water discharge is through the opening in the center of the seal and is controlled by a spring-loaded plunger suspended from a cap mounted on the upper end of the cylinder. Upper and lower float switches are suspended from the cap into the cylinder and mounted vertically. An electronic timer is provided and is wired to the float switches.

4.2 The outflow meter is placed on the pavement with the plunger sealing the water discharge opening. Sufficient water is

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

Current edition approved Jan. 1, 2015. Published January 2015. Originally approved in 2005. Last previous edition approved in 2009 as E2380/E2380M – 09. DOI: 10.1520/E2380_E2380M-15.

[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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

then poured into the cylinder to raise the switch floats to their raised or top position, which will prevent the timer from operating. The timer is reset to zero and the plunger is released to allow discharge of the water. As water flows out of the opening and through the pavement voids, the water level in the cylinder falls past the upper float switch, which activates, causing the electronic timer to begin counting. As the water level continues to fall past the level of the lower float switch, the lower float switch then activates, causing the timer to stop. The time required for the water level in the cylinder to fall from the level of the upper float switch to the level of the lower float switch is indicated on the timer. This is recorded as the outflow time.

4.3 Calibrations over a temperature range of 40 to 120°F [4 to 49°C] show no temperature affects.

5. Significance and Use

5.1 This test method is suitable as a field test to evaluate the surface drainage, and in some cases, the internal drainage of the surface course of a pavement. When used with other tests, the outflow time may be used to evaluate the texture produced by an asphalt concrete mix, a finishing method used on Portland cement concrete pavement, and refinishing operations on an old pavement surface. Test results will correlate with other methods such as the CTMeter (Test Method E2157), MPD (Practice E1845), and MTD (Test Method E965).

NOTE 1—The reciprocal of the outflow time is highly correlated with the MPD except when the surface is highly porous since the MPD is a measure of the surface texture and does not account for the water flowing through the surface pores.

5.2 The outflow times measured by this method are an indication only, and are not meant to provide a complete assessment of the pavement surface friction, or wet weather safety characteristics.

5.3 This test method does not necessarily correlate or agree with other methods of measuring pavement surface characteristics. It is up to the operator to determine the correlation of each method considered.

6. Apparatus and Materials

6.1 The essential elements of the apparatus, shown in Fig. 1, consists of the following:

6.1.1 *Upper and Lower Float Switch*—Suspended from a cap into the cylinder.

6.1.2 *Plunger*—Suspended from a cap mounted on the upper end of the cylinder.

6.1.3 *Rubber Sealing Ring*—The sealing rings shall be made of neoprene rubber and have a durometer level of 70 ± 5.

6.1.4 *Timer*—An electrical timer with at least a three-digit display indicating the elapsed time to the nearest 1.0 s, or in case of calibration or research to 0.01 s or better.

6.1.5 *Water*—Water shall be clean and have no wetting agents or detergents added, and when calibrated, distilled water shall be used.

6.1.6 *Brushes*—A broom or a hand-held wire brush shall be used to clean the test area, if needed.

7. Calibration

7.1 Calibration of the outflow meter is as follows:

7.1.1 Water volume shall be no less than 650 cc [39.7 cu in.] and no greater than 700 cc [42.7 cu in.].

7.1.2 Outlet orifice shall be made of synthetic sapphire material.

7.1.3 The bore diameter shall be 4.877 ± 0.0254 mm [0.192 ± 0.001 in.].

7.1.4 The bore length shall be 2.54 ± 0.00254 mm [0.100 ± 0.0001 in.].

7.1.5 Bore concentricity within 0.0508 mm [0.002 in.].

7.1.6 Edge sharpness within 0.0508 mm [0.002 in.].

7.1.7 Bore finish to 50.8 µm [2 µin].

7.1.8 Bottom seal thickness shall be no less than 6 mm [0.2362 in.] or more than 7 mm [0.2756 in.].

7.1.9 Bottom seal ID shall be no less than 60 mm [2.362 in.] or more than 65 mm [2.559 in.].

7.1.10 Bottom seal OD shall be no less 100 mm [3.937 in.] or more than 105 mm [4.134 in.].

7.1.11 Bottom seal shall be neoprene rubber with a 70 ± 5 durometer.

7.1.12 Lower switch shall contact at 89.9 to 101.6 mm [3.50 to 4 in.] from the lower extremities of the bottom seal.

7.1.13 Upper switch shall contact at 190.5 to 203.2 mm [7.50 to 8 in.] from the lower extremities of the bottom seal.

7.1.14 A 4.877-mm [0.192-in.] wire lapped orifice shall be put in a 4-mm [0.16-in.] thick flat metal plate for sealing purposes. The outflow time must be at least 22 s but less than 23 s on five consecutive tests to qualify for calibration status on the calibration plate. When measuring to 1⁄1000 of a second, a CV of 0.65 % shall be met.

8. Procedure

8.1 *Test Area*—Inspect the pavement surface to be measured and select a homogeneous area that contains no unique, localized features such as paint, holes, bumps, cracks, or joints. If there is any loose or semi-adhered dirt, debris, or deteriorated surface material, thoroughly clean the pavement surface in the area where the test is to be taken using a broom or stiff wire brush. On pavements that have just been under traffic, tests performed without cleaning will give actual drainage capability.

8.2 *Measurement*—Place the outflow meter on the pavement making sure that it is stable and uniformly contacts the rubber sealing ring to the pavement. On the first test, wet the plunger sealing ring by holding it close to the seat and pour in a little water. Set the plunger by pushing down on the handle until the plunger seal enters the seat, and fill the cylinder with water. For accurate measurement, the water level must extend over the top float switch sufficiently to allow air bubbles trapped between the pavement surface and the plunger to escape, and the surface water shall have a chance to settle down before the water level reaches the top float switch. Make sure the timer is reset to zero. Carefully pull the plunger up while applying an equal counter force downward on the handle. When the plunger seal is released from the seat, this becomes a hands-off operation. A spring will return the plunger to its most upright position. From this point, the outflow meter works automatically and should

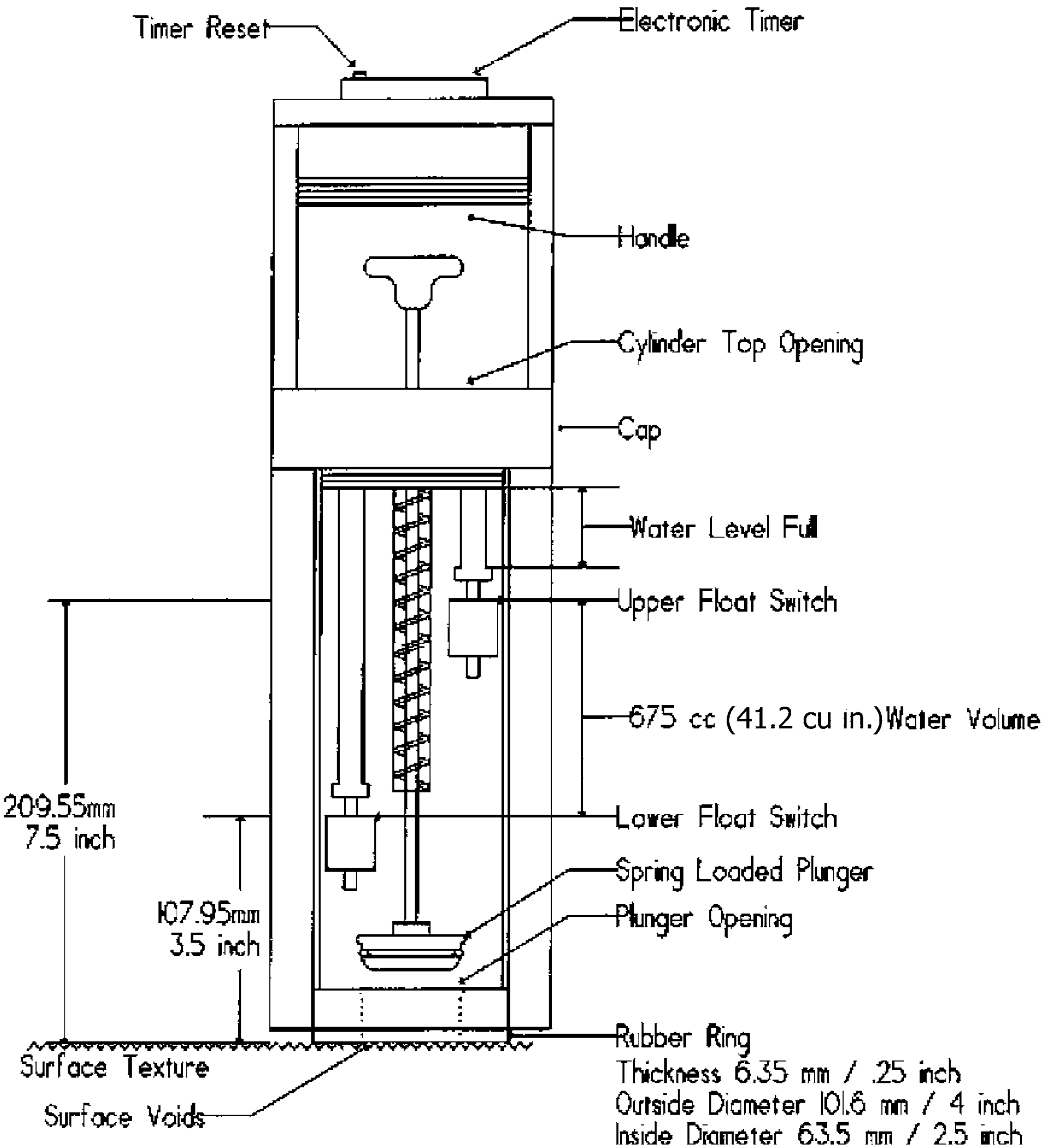

FIG. 1 Outflow Meter

not be touched until the test is over. When the lower float switch is activated and the timer stops, the plunger may be reset to save water and be ready to be filled with water for the next test. After each test, the outflow meter timer reading and the location of the test should be recorded.

8.3 *Number of Measurements*—The more tests that are performed, the better the average pavement drainage information will be. In any case, a minimum of four randomly spaced tests shall be performed and the arithmetic average of the test times shall be reported as the average time for the section of the pavement being evaluated.

8.4 For each pavement test section, the arithmetic average of all outflow meter test times will be determined and recorded to the 0.01 s. The following equation will be used to estimate the mean texture depth:

$$MTD = 3.114/OFT + 0.636 \quad (1)$$

where:

MTD = volumetric texture depth as determined by Test Method E965.

9. Faulty Tests

9.1 Tests that are manifestly faulty, or that give outflow times differing by more than 10 s from the average of all tests on the same pavement surface, shall be treated in accordance with Practice E178 on outlying observations.

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 Ambient air temperature,
10.1.4 Pavement temperatures (optional),
10.1.5 Number of measurements, and
10.1.6 Outflow times recorded.

11. Precision and Bias

11.1 *Precision*—The precision (the standard deviation) of the outflow meter that reads only whole seconds is 0.187 s and has a coefficient variation (CV) of 0.85 % when run on the calibration plate. The unit that reads to 1⁄1000 of a second has a standard deviation of 0.143 s (CV of 0.63 %).

11.2 *Bias*—Because the whole second unit truncates, it has a bias of 0.6 s as compared to the 1⁄1000 of a second unit.

REFERENCES

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(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) Wambold, J. C. and Henry, J. J., "NASA Wallops Tire/Runway Friction Workshops 1993-2002," Report TP 14190E, Transportation Development Centre (TDC) of Transport Canada (TC), September 2002.

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