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Standard Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire[1]

This standard is issued under the fixed designation E274; 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 skid resistance of paved surfaces with a specified full-scale automotive tire.

1.2 This test method utilizes a measurement representing the steady-state friction force on a locked test wheel as it is dragged over a wetted pavement surface under constant load and at a constant speed while its major plane is parallel to its direction of motion and perpendicular to the pavement.

1.3 The values measured represent the frictional properties obtained with the equipment and procedures stated herein and do not necessarily agree or correlate directly with those obtained by other pavement friction measuring methods. The values are intended for use in evaluating the skid resistance of a pavement relative to that of other pavements or for evaluating changes in the skid resistance of a pavement with the passage of time. The values are insufficient to determine the distance required to stop a vehicle on either a wet or a dry pavement. They are also insufficient for determining the speed at which control of a vehicle would be lost, because peak and side force friction are also required for these determinations.

1.4 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are provided for information only.

1.5 *This standard does not purport to address all of the safety problems 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.* For specific safety precautions, see Section 5.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E178 Practice for Dealing With Outlying Observations

E501 Specification for Rib Tire for Pavement Skid-Resistance Tests

E524 Specification for Smooth Tire for Pavement Skid-Resistance Tests

E867 Terminology Relating to Vehicle-Pavement Systems

E1136 Specification for A Radial Standard Reference Test Tire

F377 Practice for Calibration of Braking/Tractive Measuring Devices for Testing Tires

F457 Test Method for Speed and Distance Calibration of Fifth Wheel Equipped With Either Analog or Digital Instrumentation

3. Summary of Test Method

3.1 The test apparatus consists of an automotive vehicle with one or more test wheels incorporated into it or forming part of a suitable trailer towed by a vehicle. The apparatus contains a transducer, instrumentation, a water supply and proper dispensing system, and actuation controls for the brake of the test wheel. The test wheel is equipped with a standard pavement test tire. See 4.4 for tire references.

3.2 The test apparatus is brought to the desired test speed. Water is delivered ahead of the test tire and the braking system is actuated to lock the test tire. The resulting friction force acting between the test tire and the pavement surface (or some other quantity that is directly related to this force) and the speed of the test vehicle are recorded with the aid of suitable instrumentation.

3.3 The skid resistance of the paved surface is determined from the resulting force or torque record and reported as skid number (SN), which is determined from the force required to slide the locked test tire at a stated speed, divided by the effective wheel load and multiplied by 100.

4. Apparatus

4.1 *Vehicle*—The vehicle with one test tire locked shall be capable of maintaining test speeds of 40 to 60 mph (65 to 100 km/h) within ±1.0 mph (±1.5 km/h) during a test on a level pavement having a skid number of 50.

4.2 *Braking System*—The test wheel shall be equipped with a suitable brake. The brake system shall be capable of locking the wheel at the conditions specified in 4.1 and maintaining the locked-wheel condition throughout the test.

[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.

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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.

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4.3 *Wheel Load*—The apparatus shall be of such a design as to provide an equal static load of 1085 ±15 lbf (4800 ± 65 N) to each test wheel and on detachable trailers a static download of 100 to 200 lbf (450 to 900 N) at the hitch point.

4.4 *Tire and Rim*—The test tire shall be one of the standard tires for the pavement test as specified in Specification E501 or E524, and it shall be mounted on a suitable 15 by 6 in. rim. The tire mounting for rotation consideration is important to minimize tread separation. The tire shall rotate clockwise when viewed facing the serial number stamped on the tire. Therefore, when testing the left wheel path, the serial number should face the center of the lane. Since all rims do not have the same offset from the hub, replacement rims must be of the same offset to ensure consistent alignment of the tire with the water path. The data from the two tires are not interchangeable. **(1)**[3] Alternative testing for special purposes may be performed with other tires, such as a radial standard reference test tire of Specification E1136.

4.5 *Instrumentation*:

4.5.1 *General Requirements for Measuring System*—The instrumentation system shall conform to the following overall requirements at ambient temperatures between 40 and 100°F (4 and 40°C):

Overall system accuracy—±1½ % of applied load from 200 lbf (900 N) to full scale; for example, at 200 lbf, applied calibration force of the system output shall be determinable within ±3 lbf (±14 N).

Time stability of calibration—10 h, min.

The exposed portions of the system shall tolerate 100 % relative humidity (rain or spray) and all other adverse conditions, such as dust, shock, and vibrations which may be encountered in highway operations.

4.5.2 *Force-Measuring Transducer*—The tire force-measuring transducer shall be of such design as to measure the tire-road interface force with minimum inertial effects **(2)**. Transducers are recommended to provide an output directly proportional to force with hysteresis less than 1 % of the applied load, nonlinearity less than 1 % of the applied load up to the maximum expected loading, and sensitivity to any expected cross-axis loading or torque loading less than 1 % of the applied load. The force transducer shall be mounted in such a manner as to experience less than 1 deg angular rotation with respect to its measuring plane at the maximum expected loading.

4.5.3 *Torque-Measuring Transducer*—Torque transducers provide an output directly proportional to torque with hysteresis less than 1 % of the applied load and nonlinearity up to the maximum expected loading less than 1 % of the applied load. It should have sensitivity to any cross-axis loading less than 1 % of the applied load.

4.5.4 *Additional Transducers*—Force transducers for measuring quantities such as vertical load, etc., shall meet the recommendations stated in 4.5.2.

4.5.5 *Vehicle Speed-Measuring Transducers*—Transducers such as "fifth wheel" or free-rolling wheel coupled tachometers shall provide speed resolution and accuracy of ± 1.5 % of the indicated speed or ±0.5 mph (±0.8 km/h), whichever is greater. Output shall be directly viewable by the driver and shall be simultaneously recorded. Fifth wheel systems shall conform to Method F457.

4.6 *Signal Conditioning and Recorder System*:

4.6.1 Transducers that measure parameters sensitive to inertial loading shall be designed or located in such a manner as to minimize this effect **(3)**. If the foregoing is not practical, data correction must be made for these effects if they exceed 2 % of actual data during expected operation. All signal conditioning and recording equipment shall provide linear output and shall allow data reading resolution to meet the requirements of 4.5.1. All systems, except the smoothing filter recommended in 4.6.2, shall provide a minimum bandwidth of at least 0 to 20 Hz (flat within ±1 %).

4.6.2 It is recommended that an electronic filter, typically between 4.8 Hz/-3db/4 pole Bessel-type and a 10 Hz/-3db/8 pole Butterworth filter, selected from the types described in Ref **(4)** be installed in the signal conditioning circuit preceding the electronic divider and integration calculation of SN as described in 9.4.

4.6.3 All strain-gage transducers shall be equipped with resistance shunt calibration resistors or equivalent that can be connected before or after test sequences. The calibration signal shall be at least 50 % of the normal vertical load and shall be recorded.

4.6.4 Tire friction force or torque and any additional desired inputs, such as vertical load, wheel speed, etc., shall be recorded in phase (±5° over a bandwidth of 0 to 20 Hz). Vehicle speed shall also be recorded. All signals shall be referenced to a common time base.

4.6.5 A signal to electrical noise ratio of at least 20 to 1 is desirable on all recorded channels.

4.7 *Pavement Wetting System*:

4.7.1 The water being applied to the pavement ahead of the test tire shall be supplied by a nozzle conforming to the dimensions in Fig. 1. The quantity of water applied at 40 mph (65 km/h) shall be 4.0 gal ± 10 %/min·in. (600 mL/min·mm ±10 %) of wetted width. The water layer shall be at least 1 in. (25 mm) wider than the test tire tread and applied so the tire is centrally located between the edges. The volume of water per inch (or millimetre) of wetted width shall be directly proportional to the test speed **(5)**.

4.7.2 The nozzle configuration and position shall ensure that the water jets shall be directed toward the test tire and pointed toward the pavement at an angle of 20 to 30°. The water shall strike the pavement 10 to 18 in. (250 to 450 mm) ahead of the vertical axes through the centerline of the test wheel. The nozzle shall be 1 in. (25 mm) above the pavement or the minimum height required to clear obstacles that the tester is expected to encounter, but in no case more than 4 in. (100 mm) above the pavement.

4.7.3 Water used for testing shall be reasonably clean and have no chemicals such as wetting agents or detergents added.

5. Safety Precautions

5.1 The test vehicle, as well as all attachments to it, shall comply with all applicable state and federal laws. All necessary

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

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