Designation: E 503/E 503M – 88 (Reapproved 2004)

Standard Test Methods for Measurement of Skid Resistance on Paved Surfaces Using a Passenger Vehicle Diagonal Braking Technique[1]

This standard is issued under the fixed designation E 503/E 503M; 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 These test methods cover the measurement of skid resistance on paved surfaces with a passenger vehicle equipped with specified full-scale vehicle tires and using the diagonal braking mode. These test methods include the following:

1.1.1 *Full-Stop Method*—This represents the nonsteady-state skid resistance on two diagonally locked wheels, as the vehicle decelerates over a wetted pavement surface under specified limits of static wheel load and from a desired speed. The vehicle shall remain essentially parallel to its original direction of motion.

1.1.2 *Pulse-Braking Method*—The deceleration resulting from momentary diagonal wheel lockup (pulse braking) is measured. The vehicle decelerates over a wetted pavement surface under specified limits of static wheel load and at a desired speed. The vehicle shall remain essentially parallel to its original direction of motion.

1.2 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents: therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the specification.

2. Referenced Documents

2.1 *ASTM Standards:* [2]

E 178 Practice for Dealing with Outlying Observations

E 501 Specification for Standard Rib Tire for Pavement Skid-Resistance Tests

E 524 Specification for Standard Smooth Tire for Pavement Skid-Resistance Tests

F 403 Test Method for Tires for Wet Traction in Straight-Ahead Braking, Using Highway Vehicles

F 457 Method for Speed and Distance Calibration of a Fifth Wheel Equipped with Either Analog or Digital Instrumentation

3. Summary of Test Methods

3.1 The test apparatus for both test methods consists of a passenger vehicle with four wheels, of which two are used for test purposes. The apparatus contains transducers, instrumentation, and a selected brake system for the test wheels. The test wheels are to be equipped with the Standard Pavement Test Tires described in Specification E 501 or E 524.

3.2 For both test methods, the pavement in the test lane is wetted with two applications from a water wagon equipped with a spray bar or other means of distributing water evenly and rapidly. The test vehicle is brought above the desired test speed and permitted to coast onto the wetted section until proper speed is attained. The brakes are then promptly and forcefully applied to cause quick lock-up of the test wheels.

3.3 For the full-stop method, the vehicle operator maintains brake application until a complete stop is obtained. The resulting distance required to stop is recorded with the aid of suitable instrumentation, and the velocity at the moment of brake application is noted. The skid resistance of the paved surface is determined from the resulting stopping distance measurement and test speed as stopping distance number, SDN, as determined from the equations given in Section 10, or as stopping distance, SD.

3.4 For the momentary deceleration (pulse-braking) method, the vehicle operator maintains the locked wheel condition for approximately 1 s, and then releases the brakes. The resulting deceleration during braking is recorded with the aid of suitable instrumentation, and the velocity during brake application is noted. The skid resistance of the paved surface is determined from the resulting deceleration measurement and test speed as diagonal braking number, DBN, as determined from the equation given in Section 10.

[1] These test methods are under the jurisdiction of ASTM Committee E17 on Vehicle-Pavement Systems and are 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.

NOTE 1—Since tire-tread design has a significant effect on pavement surface skid-resistance measurements, ranking and comparison of pavement surfaces using the Specification E 501 test tire might be considerably different from that using the Specification E 524 test tire.

NOTE 2—Since speed has a significant effect on pavement surface skid-resistance measurements, ranking and comparison of pavement surfaces at higher speeds might be considerably different from that at lower speeds.

4. Significance and Use

4.1 The knowledge of vehicle stopping distance or deceleration serves as an additional tool in characterizing the pavement surface skid resistance. When used in conjunction-with other physical and chemical tests, the skid resistance values derived from these test methods may determine the suitability and adequacy of paving materials or finishing techniques. Improvements in pavement maintenance practices and schedules may result from use of these test methods.

4.2 The stopping distance or deceleration values measured by these two test methods with the equipment and procedures stated herein do not necessarily agree or correlate directly with other methods of skid-resistance measurements. These test methods are suitable where direct comparison between pavement surfaces are to be made within the same test program.

5. Apparatus

5.1 *Vehicle*—The vehicle shall be a four-wheel passenger car or a light truck, preferably equipped with a heavy-duty suspension system.

5.1.1 *Rear Axle*—Posi-traction or other limited-slip differentials must not be used.

5.1.2 *Braking System*—The brake system shall be capable of rapidly locking the diagonal test wheels and maintaining a locked-wheel condition throughout the test. The test vehicle shall be equipped with appropriate brake system cut-off valves, either manual or electric to prevent brake actuation on the diagonal wheel pair not equipped with test tires.

5.1.3 *Wheel Load*—The static wheel load of the vehicle shall not exceed the rated load of the Standard Tire for Pavement Tests in accordance with Specification E 501 or E 524 and shall be as close to the stipulated load as possible. The vehicle gross weight shall not be less than 3200 lb [1.45 mg].

5.1.4 *Steering System*—Power steering is recommended to minimize control requirements that might result from brake application.

5.1.5 *Tire and Rim*—The test tires shall be the Standard Tire for Pavement Tests of Specification E 501 or E 524 mounted on a 15 by 6 JJ rim. Unbraked wheels of the test vehicle shall be equipped with standard production tread designs, and shall be maintained to provide at least 80 % of "new" tread depth.

5.1.6 *Safety Equipment*—Vehicle lighting and signing shall conform to local requirements.

5.2 *Instrumentation*:

5.2.1 *Vehicle Speed-Measuring Transducer and Indicator*—The transducer shall be a "fifth-wheel"-mounted tachometer generator or pulse transducer and speed-indicating meters shall provide speed resolution and accuracy of ±1.0 mph [±1.5 km/h]. Output shall be directly viewed by the operator and recorded if desired. The slewing rate of the fifth wheel shall be within the limits described in Test Method F 403.

5.2.2 *Distance-Measuring Transducer and Counter*—For the full-stop method, a "fifth-wheel"-mounted transducer, producing at least 1 count per foot [3 counts per metre] shall actuate a high-speed distance counter, visible to the operator, and capable of accepting a count rate equivalent to the number of counts produced at the test speed, or the transducer output shall be recorded.

NOTE 3—The fifth wheel assembly with speed and distance readouts should meet requirements specified in Method F 457.

5.2.3 *Vehicle Test Wheel Revolutions*—Pulse transducers, capable of providing at least 1 count per revolution, or tachometer generators, meeting specifications given in Test Method F 403, shall be mounted on each diagonal-braked wheel to provide indication of wheel lockup. Output shall be directly viewed by operator, recorded, or both.

5.2.4 *Pressure-Sensitive Switch*—A pressure-sensitive switch, such as a hydraulic brake-light switch, requiring 70 to 90 psi [480 to 620 kPa] pressure to close, shall be installed in the wheel hydraulic brake system to actuate the stopping-distance counter.

5.2.5 *Acceleration-Measuring Transducer or Meter*—For the momentary deceleration (pulse-braking) method, an accelerometer, ranged to ±1 g full scale and mounted near the vehicle center of gravity to measure longitudinal deceleration of the vehicle, shall provide deceleration resolution and accuracy of ±0.01 g. The accelerometer frequency response: direct current to minimum 10 Hz (flat ±1.0 %). Transducer output shall be recorded; meter readings shall be monitored by test observer in vehicle.

5.2.6 *Low-Pass Filter*—To minimize vehicle and roadway related vibrations from effecting the deceleration data, a low-pass filter shall be connected to the signal output of the accelerometer. The filter shall be flat ±2 % from direct current to 5 Hz, −3 dB at 9 ± 1 Hz and rolloff at between 12 and 24 dB per octave.

5.2.7 *Multichannel Recorder*—If a multichannel recorder is used during tests with either method, the recorder should meet the requirements specified in Test Method F 403.

5.2.8 *Power Supply*—The power supply for transducers and recorder (optional) should meet requirements specified by transducer and recorder manufacturers.

6. Calibration

6.1 *Speed*—Calibrate the speed indicator of the test vehicle at the test speed by determining the time for traversing, at constant speed, a reasonably level, straight, and accurately measured pavement at least 0.5 mile (0.8 km) in length. Make a minimum of two speed determinations at the test speed. The speed shall be accurate to within ±1 mph [±1.5 km/h] and repeatable to within ±2 mph [±3.0 km/h] when calibrated at 40 mph [65 km/h].

6.2 *Distance*—Calibrate the distance transducer and counter by traversing, at the approximate test speed, a reasonably level, straight, and accurately measured pavement at least 0.5 mile [0.8 km] in length. Initiate the calibration from a complete stop at the beginning of the test course and terminate by stopping at