Designation: E1337 – 24

Standard Test Method for Determining Longitudinal Peak Braking Coefficient (PBC) of Paved Surfaces Using Standard Reference Test Tire[1]

This standard is issued under the fixed designation E1337; 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 peak braking coefficient (PBC) of paved surfaces using a standard reference test tire (SRTT) as described in Specification F2493 that represents current technology passenger car radial tires. General test procedures and limitations are presented for determining peak braking coefficient independent of surface conditions. Actual surface test conditions are determined and controlled by the user at the time of test. Test and surface condition documentation procedures and details are specified. This measurement quantifies the peak braking coefficient at the time of test, and does not necessarily represent a maximum or fixed value.

1.2 There are many specifications published that refer to the ASTM E1337 PBC Standard assuming the E1136 SRTT in determining peak brake coefficient. Correlation equations for converting data collected using an F2493 SRTT to the older E1136 specification, and converting an older E1136 specification for use with F2493 data, are included in 12.4.

1.3 This test method utilizes a measurement representing the peak braking force on a braked test tire passing over a road surface. This test is conducted with a tire under a nominal vertical load at a constant speed while its major plane is parallel to its direction of motion and perpendicular to the pavement.

1.4 The measured peak braking coefficient obtained with the equipment and procedures stated herein may not necessarily agree or correlate directly with those obtained by other surface coefficient measuring methods.

1.5 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

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

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

E274/E274M Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire

E867 Terminology Relating to Vehicle-Pavement Systems

F408 Test Method for Tires for Wet Traction in Straight-Ahead Braking, Using a Towed Trailer

F2493 Specification for P225/60R16 97S Radial Standard Reference Test Tire

3. Terminology

3.1 *Definitions:*

3.1.1 *chirp test*—the progressive application of brake torque required to produce the maximum value of longitudinal braking force that will occur prior to wheel lockup, with subsequent brake release to prevent any wheel lockup (tire slide).

3.1.2 For other definitions pertaining to this standard, see Terminology E867 and Test Method F408.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *braking force coefficient, tire*—the ratio of braking force to vertical load.

3.2.2 *braking force coefficient, tire, peak*—the maximum value, as defined in 12.2, of tire braking force coefficient that occurs prior to wheel lockup as the braking torque is progressively increased.

3.2.3 *braking force coefficient, tire, slide*—the value of the braking force coefficient obtained on a locked wheel.

[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 www.astm.org/contact. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.2.4 *braking force, tire*—the negative longitudinal force resulting from braking torque application.

3.2.5 *braking torque*—the negatively directed wheel torque.

3.2.6 *longitudinal force, tire (F_x)*—the component of a tire force vector in the *X*' direction.

3.2.7 *tire-axis system*—the origin of the tire-axis system is the center of the tire contact. The *X*' axis is the intersection of the wheel plane and the road plane with a positive direction forward. The Z' axis is perpendicular to the road plane with a positive direction downward. The Y' axis is in the road plane, its direction being chosen to make the axis system orthogonal and right-hand (see Fig. 1 in Test Method F408).

3.2.8 *tire forces*—the external forces acting on the tire by the road.

3.2.9 *torque wheel (T)*—the external torque applied to a tire from a vehicle about the wheel spin axis. Driving torque is positive wheel torque; braking torque is negative wheel torque.

3.2.10 *vertical load (F_z)*—the downward vertical component of force between the tire and the road.

4. Summary of Test Method

4.1 The measurements are conducted with a standard reference test tire (Specification F2493) mounted on a test trailer towed by a vehicle. The trailer contains a transducer, instrumentation, and actuation controls for the braking of the test tire. See 6.6 for trailer instrumentation.

4.2 The test apparatus is normally brought to a test speed of 40 mph (64 km/h). The brake is progressively applied until sufficient braking torque results to produce the maximum braking force that will occur prior to wheel lockup. Longitudinal force, vertical load, and vehicle speed are recorded with the aid of suitable instrumentation and data acquisition equipment.

4.3 The peak braking coefficient of the road surface is determined from the ratio of the maximum value of braking force to the simultaneous vertical load occurring prior to wheel lockup as the braking torque is progressively increased.

5. Significance and Use

5.1 Pavement surfaces have different traction characteristics, depending on many factors. Surface texture, binder content, usage, environmental exposure, and surface conditions (that is, wet, dry) are some of the factors.

5.2 The measured values represent peak braking coefficients for tires of the general type in operation on passenger vehicles, obtained with a towed test trailer on a prescribed road surface, under user-defined surface conditions. Such surface conditions may include the water depth used to wet the road surface and the type of water application method. Variations in these conditions may influence the test results.

6. Apparatus

6.1 The apparatus consists of a tow vehicle and test trailer. The vehicle and trailer must comply with all legal requirements applicable to state laws when operated on public roads.

6.2 *Tow Vehicle*—The vehicle shall have the capability of maintaining a test speed of 40 mph (64 km/h) within ±0.5 mph (±0.8 km/h), even at maximum level of application of braking forces.

6.3 *Test Trailer*—The test wheel shall be equipped with a sufficient braking torque to produce the maximum value of braking test wheel longitudinal force at the conditions specified.

6.3.1 Each of the trailer wheels shall have a suspension capable of holding toe and camber changes to within ±0.05° with maximum vertical suspension displacements under both static and dynamic conditions.

6.3.2 The rate of brake application shall be sufficient to control the time interval between initial brake application and peak longitudinal force to be between 0.3 and 0.5 s.

6.4 *Vertical Load*—The trailer shall be of such a design as to provide a static load of 1180 ± 15 lbf (5249 ± 67 N) to the test wheel and, on detachable trailers, a static down load of 100 to 200 lbf (445 to 890 N) at the hitch point.

6.5 *Tire and Rim*—The test tire shall be the standard reference test tire (SRTT) for pavement tests, as specified in Specification F2493, mounted on a suitable 16 by 6.5 in. rim.

6.5.1 When irregular wear or damage results from tests, or when wear or usage influences the test results, the use of the tire should be discontinued.

6.6 *Instrumentation:*

6.6.1 *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 38 °C):

6.6.1.1 Overall system accuracy of ±1.5 % of applied load from 200 lbf (890 N) to full scale; for example, at 200 lbf (890 N), applied calibration force of the system output shall be determinable within ±3 lbf (±13 N).

6.6.1.2 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.

6.6.1.3 *Braking Forces*—The braking force measuring transducer shall measure longitudinal reaction force within a range between 0 and 2000 lbf (0 and 8.9 kN) generated at the tire-pavement interface as a result of brake application. The tire force-measuring transducer shall be of such design as to measure the tire-pavement interface force with minimum inertial effects. 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° angular rotation with respect to its measuring plane at the maximum expected loading.

6.6.1.4 *Vertical Load*—The vertical load measuring transducer shall measure the vertical load at the test wheel during brake application. The transducer shall have the same specifications as those described in 6.6.1.3.