Designation: F408 – 21

Standard Test Method for Tires for Wet Traction in Straight-Ahead Braking, Using a Towed Trailer[1]

This standard is issued under the fixed designation F408; 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 braking traction of tires designed for passenger cars or light trucks. Such braking traction measurements are applicable to conditions wherein the vehicle is traveling straight ahead on a wet, paved surface.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 *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.*

1.4 *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 Test Method for Skid Resistance of Paved Surfaces Using a Full-Scale Tire

E1337 Test Method for Determining Longitudinal Peak Braking Coefficient (PBC) of Paved Surfaces Using 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

F538 Terminology Relating to Characteristics and Performance of Tires

F1650 Practice for Evaluating Tire Traction Performance Data Under Varying Test Conditions

3. Terminology

3.1 *Definitions:*

3.1.1 *braking force, [F], n—of a tire*, the negative longitudinal force resulting from braking torque application. **F538**

3.1.2 *braking force coefficient, n—of a tire*, the ratio of braking force to normal force. **F538**

3.1.3 *braking force coefficient, peak, n—of a tire*, the maximum value of tire braking force coefficient that occurs prior to wheel lockup as the braking torque is progressively increased. **F538**

3.1.4 *braking force coefficient, slide, n—of a tire*, the value of braking force coefficient obtained on a locked wheel. **F538**

3.1.5 *braking torque, [ML^2/ T^2], n—of a vehicle*, the negative wheel torque. **F538**

3.1.6 *lockup, n—of a wheel*, the condition of a wheel in which its rotational velocity about the wheel spin axis is zero and it is prevented from rotating in the presence of applied wheel torque. **F538**

3.1.7 *longitudinal force, [F], n—of a tire,* the component of the tire force vector in the X' direction. **F538**

3.1.8 *normal force, [F], n—of a tire*, the component of a tire force vector in the Z' direction. **F538**

3.1.9 *skid number (SN), n*—slide braking force coefficient multiplied by 100. **F538**

3.1.10 *test run, n—in tire testing*, a single pass over a given test surface, or the acquisition of a sequence of data, or both, in the act of testing a tire or tire set under selected test conditions. **F538**

3.1.11 *tire axis system, n*—the origin of the tire-axis system is the center of the tire contact where 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, and the Y'-axis is in the road plane, its direction being chosen to make the axis system orthogonal and right-hand. (See Fig. 1.) **F538**

[1] This test method is under the jurisdiction of ASTM Committee F09 on Tires and is the direct responsibility of Subcommittee F09.20 on Vehicular Testing.

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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.

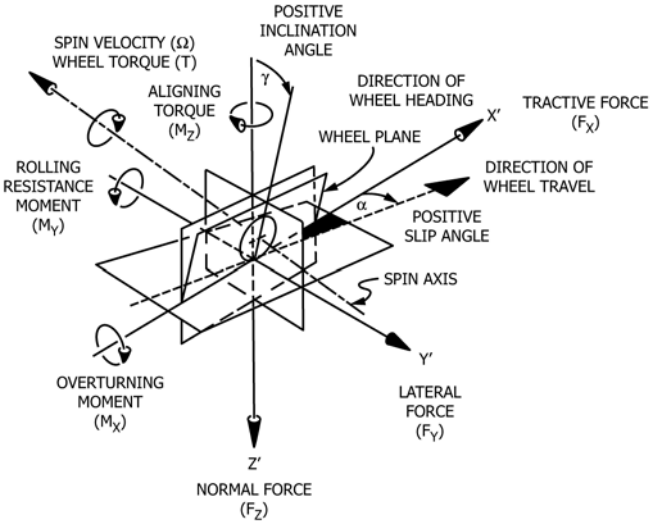

FIG. 1 Tire-Axis System

3.1.12 *tire forces, [F], n*—the external forces acting on a tire by the road. F538

3.1.13 *torque, [FL], n—of a wheel*, the external torque applied to a tire from a vehicle about the wheel spin axis.

3.1.13.1 *Discussion*—Driving torque is positive wheel torque; braking torque is negative wheel torque. F538

3.1.14 *vertical load, n*—the normal reaction of the tire on the road which is equal to the negative of the normal force. F538

4. Summary of Test Method

4.1 The measurements are conducted on tires mounted on a trailer towed by a vehicle. Brakes are applied firmly until one or both test tire(s) are locked and then held locked for a period of at least 1.5 s at speeds ranging from 32 km/h (20 mph) to 96 km/h (60 mph).

4.2 Recommended vehicle test speeds are: 32, 64, and 96 km/h (20, 40, and 60 mph).

5. Significance and Use

5.1 The measured values are traction properties of tires obtained with the towed trailer described here on a given road surface, under given environmental conditions (ambient and road surface temperature, humidity, wind speed and direction, purity and film depth of water used to wet the road surface). They are carried out in accordance with the stated test procedures and reflect the performance of the total tire-vehicle environmental system. A change in any of these factors may change the measurements on a subsequent run of the test.

5.2 These test methods are suitable for research and development purposes, where tires are compared during a single series of tests. They may not be suitable for regulatory statutes or specification acceptance, because the values obtained may not necessarily agree or correlate either in rank order or absolute traction performance level with those obtained on other road surfaces (or the same surface after additional wear), under other environmental conditions, or other towed trailers, or other test devices, or with results obtained with other test procedures.

6. Apparatus

6.1 The apparatus consists of tow vehicle and trailer. Vehicle and trailer must comply with all applicable state and federal laws when operated on public roads.

6.2 *Tow Vehicle:*

6.2.1 The tow vehicle shall have the capability of towing the trailer at specified speeds in the range from 32 to 96 km/h (20 to 60 mph), which are to be kept constant to within 0.8 km/h (0.5 mph), even at maximum level of application of braking forces.

6.2.2 The tow vehicle shall be equipped with the following accessories:

6.2.2.1 Equipment to actuate brakes on towed trailer,

6.2.2.2 A water tank to store sufficient water to supply the watering system unless external watering is used,

6.2.2.3 Recording equipment to record signals from transducers installed on the towed trailer,

6.2.2.4 Hitch with adjustable height for towing the trailer, and

6.2.2.5 Optional equipment to monitor and control brakeline pressure, brake application rate, and water application rate.

6.3 *Towed Trailer*—The trailer shall be equipped with a tow hitch and one or two test wheels which shall be instrumented as described. A self-watering system is optional (see 6.3.6). Trailers shall be designed to accommodate the range of passenger car and light truck rim sizes to be tested.

6.3.1 The hitch height shall be no higher than the loaded tire radius, and the distance from hitch ball to axle centerline shall be no less than ten times the hitch height. For external watering, the trailer hitch on the tow vehicle shall be so arranged that the trailer tires will run in tracks separate from the tire tracks of the tow vehicle. The minimum track offset of the test tire(s) with respect to the track of the tow vehicles should be 0.3 m (12 in.).

6.3.2 The trailer shall have provisions for adjustment of vertical load from 65 to 110 % of the appropriate maximum load as specified in the current yearbook of the appropriate tire and rim standards organization. To meet this requirement for all rim sizes, two or more trailers designed for different load ranges and equipped with appropriate wheel adaptors may be necessary.

6.3.3 Each of the test wheels shall be equipped with a typical or special automotive hydraulic brake system which can apply sufficient braking torque to initiate and maintain lockup of the test wheel(s) for the duration of the test.

6.3.4 Each of the test wheels shall have a suspension capable of limiting change of toe and camber to within ±0.05° with maximum vertical suspension displacements. Suspension arms and bushings shall have sufficient rigidity necessary to minimize free play and compliance under application of maximum braking forces. The suspension system shall provide adequate load-carrying capacity and be of such a design as to isolate suspension resonance.