Designation: ~~F538 – 21~~ F538 – 22

Standard Terminology Relating to Characteristics and Performance of Tires[1]

This standard is issued under the fixed designation F538; 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 terminology primarily covers definitions for technical terms that occur in ASTM Committee F09 standards on the characteristics and performance of tires.

1.2 Definitions for terms that may also be used in other technologies, such as vehicle behavior, are worded to cover both areas.

1.3 When any definition in this terminology (that does not have the limiting phrase) is quoted out of context, editorially insert the limiting phrase *in a tire* after the dash following the term. This will properly limit the field of application of the term and definition.

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. Terminology

2.1 *Definitions:*

accelerometer, *n*—an instrument that senses inertial reaction to measure linear or angular acceleration. **F811**

accuracy, *n*—a measurement concept that describes the degree of correspondence between an average measured value and an accepted reference or standard value for the object, material or phenomenon under test.

age, *v*—to apply conditions so as to promote change of material properties. **F2838**

aging, accelerated laboratory (also: aging, laboratory), *n*—increased rate of tire material property changes under specified conditions, including temperature, inflation pressure, oxygen concentration in the filling gas, and time. **F2838, F3015**

aging, in-service, *n*—material property changes within tires due to consumer usage. **F2838, F3015**

aging, oven, *n*—accelerated laboratory aging in an elevated temperature environment. **F2838, F3015**

aging, thermal oxidative, *n*—the process whereby chemical and physical material properties of a tire change with exposure to heat and oxygen. **F2838**

[1] This terminology is under the jurisdiction of ASTM Committee F09 on Tires and is the direct responsibility of Subcommittee F09.94 on Terminology.

Current edition approved ~~April 1, 2021~~Oct. 1, 2022. Published ~~May 2021~~October 2022. Originally approved in 1977. Last previous edition approved in ~~2013~~2021 as ~~F538 – 13~~.F538 – 21. DOI: ~~10.1520/F0538-21~~.10.1520/F0538-22.

***A Summary of Changes section appears at the end of this standard**

aligning stiffness [*FL/γ*]**,** *n—of a tire*, the rate of change of tire aligning torque with respect to change in tire slip angle, usually evaluated at zero slip angle.

aligning stiffness coefficient, *n—of a tire*, the ratio of tire aligning stiffness to the tire normal force.

aligning torque [*FL*]**,***n—of a tire*, the component of a tire moment vector tending to rotate a tire about the *Z*′-axis, positive clockwise when looking in the positive direction of the *Z*′-axis. **F424**

alignment, *n*—the adjustment of various parts of the vehicle's suspension system to ensure proper handling stability and to minimize abnormal tire treadwear. **F1922**

all-season tread, *n*—tread design providing dry, wet, and snow traction performance for an optimized balance for year-round performance and which may meet the U.S. Tire Manufacturers Association (USTMA) definition for an M&S, M+S, M/S, MS, etc. marked tire (see USTMA "Snow Tire Definitions for Passenger and Light Truck (LT) Tires"). **E1136, F2493**

alternate element wear, *n*—type of element wear characterized by a pattern of an increased wear rate on alternating isolated projections; the wear may be every second projection, every third projection, every fourth projection, etc. or a combination thereof. **F1426**

analysis, *n*—an act of inspecting a shearographic or holographic (S/H) system image and associating this image with a known calibration reference. **F1364**

anomaly, *n*—a change in the strain pattern of the rubber surface of a straining block as a result of applied stress brought about through a change in atmospheric pressure on the rubber surface.

anti-lock braking system (ABS), *n*—a collection of sensing and control hardware installed on a vehicle to prevent wheel lock-up during brake application. **F1649**

average tire tread depth [*L*]**,***n*—the average of all tire groove (void) depth measurements. **F1016**

axle efficiency [*nd*]**,***n—in a vehicle*, the ratio of the sum of the wheel torques at the driven wheels to the product of driveshaft torque and axle ratio.

balancing, *n*—a process to correct for heavy or light areas of a tire and wheel assembly. **F1922**

bandwidth [1/ *T*]**,***n*—the range of frequencies within which certain performance characteristics occur; specific limits normally apply. **F811**

bead, *n—of a tire*, the part of a tire that comes in contact with the rim and is shaped to secure the tire to the rim. **F1922, F1923, F2663, F2803**

bead separation, *n*—a breakdown of bond between tire components in the bead area. **F1922**

bead unseating block, *n*—machined block of cast aluminum (also known as "shoe") used on the bead unseating fixture to press against the tire sidewall. **F2663**

belt, *n—in a tire*, a breaker that substantially restricts the carcass in a circumferential direction. **F3015**

belt edge (BE) temperature, *n*—in the cross section of a radial tire, the temperature at the edge of the stabilizer plies or belts, for example, in the rubber region of the two belt edges. **F2779, F2869**

belt separation, *n—in a tire*, a breakdown of bonding between the belts or plies or tread, or combination thereof. **F1922, F2838, F3015**

bias, *n*—the difference between the average measured test result and the accepted reference value; it measures in an inverse manner the accuracy of a test. **F337**

black sidewall, *n*—a sidewall on which only black compounds comprise the outer visible surface of the tire. **F724**

block, *n*—synonym for *element*. **F1426**

bottom out, *v*—to deform a tire by radial load on the tread until radial movement of the inside surface is stopped by the rim or other tire inside surface. **F414**

brake skid/flat spot wear, *n*—a type of irregular wear characterized by an excessive amount of wear in a footprint area of a tread due to the tread sliding on the road surface; the tread surface may show abrasion marks, may be smooth with the entire tread pattern removed, or may be worn into the internal components of the tire. **F1426**

braking coefficient [*nd*],*n*—the ratio of the braking force to the normal force on a tire.

braking force [*F*],*n—of a tire*, the negative longitudinal force resulting from braking torque application. **F408**

braking force coefficient, *n—of a tire*, the ratio of braking force to normal force. **F408**

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. **F408**

braking force coefficient, slide, *n—of a tire*, the value of braking force coefficient obtained on a locked wheel. **F408**

braking torque [ML^2/T^2],*n—of a vehicle*, the negative wheel torque. **F408**

brand, *n—of a tire*, the name under which one or more tire lines are marketed.

brand, tire, private, *n*—a brand name used by a tire seller or group of sellers who are not manufacturers.

break, *n—in a tire*, a crack or tear extending into or through the reinforcing material. **F1922**

breaker, *n—in a tire*, one or more plies under the tread region of a tire that are additional to those which extend from bead to bead. **F3015**

break-in [*L*],*n*—one or more periods of initial standardized tire operation during which tire is brought to the state which will lead to more consistent test results. **F762, F1016**

calibration tire, *n*—a witness tire designed to provide a fixed or known test value for selected properties.

candidate ~~tire,~~ tire (set), *n*—a test tire (or test tire set) that is part of an evaluation program; each candidate tire (set) usually has certain unique design or other features that distinguish it from other candidate tires (sets) in the program. **F1572, F1649, F1650, F1805, F1806, F1922, F2803**

caravan, *n—for purposes of a tire test*, two or more vehicles running in the same time frame, over the same test course(s), under similar but independent conditions. **F1922**

carcass, *n—of a tire*, the part of a tire structure that does not include the tread and sidewall rubber.

casing, *n—of a tire*, a used or treadless tire to which additional tread rubber may be attached for the purpose of retreading. **F1922**

center of tire contact, *n*—the intersection of the wheel plane and the vertical projection of the spin axis of a wheel onto the road plane.

center rib, *n—in a tire*, a rib at or near the circumferential centerline of the tread band. **F1426**

center row, *n—in a tire*, a row located at or near the circumferential centerline. **F1426**

center wear, *n*—a type of irregular wear characterized by a wear rate continuously increasing from shoulder to center of the tire tread band. **F1426**

centripetal acceleration [ML^2/T^2],*n—of a vehicle*, the component of the vector acceleration (of a point in a vehicle) perpendicular to the tangent of the path of the point and parallel to the road plane.

chip and tear (also cut and chip), *n*—a special type of irregular wear characterized by a rough tire tread surface which may contain cracks, abrasion pits or surface ruptures. **F1426**

circumferential line, *n—on a tire*, any real or imaginary circle on the surface of a tire, lying in a plane that is perpendicular to the spin axis. **F421, F870**

clinch strip, *n—in a tire*, high-modulus or high-hardness compound applied between the carcass and the sidewall in the bead area to reinforce the bead. **F724**

cold inflation pressure, *n*—the gauge pressure of a tire, measured after equilibration at ambient temperature. **F2838, F3015**

connection point, *n*—any point on the wheel or metal loading plate where the resistance measuring instrument's leads are connected. **F1971**

contained air temperature, *n*—the temperature of the air contained within the tire cavity when the tire is mounted and inflated on the proper rim. **F2779, F2869**

control tire (set), *n*—a reference tire (or reference set) repeatedly tested in a specified sequence, typically in conjunction with a candidate tire (set), throughout an evaluation ~~program.~~program, that is used to adjust data sets generated from an evaluation program or the statistical procedures used on data sets, or both, in order to offset or reduce variation in test results. **F1572, F1649, F1650, F1805, F1806, F1922, F2803**

~~Discussion—~~

~~Control tires (sets) are used for adjustment of data sets generated from an evaluation program or the statistical procedures used on data sets, or both, in order to offset or reduce variation in test results. They can also be used to improve the accuracy of candidate tire (set) data and to detect variation in test equipment.~~

convoy, *n—in tire testing*, two or more vehicles running at the same time, over the same test course, under the same interdependent conditions. **F1922**

cord, *n—in a tire*, filament(s) or plied yarns used in making a tire ply. **F1922**

cornering force [ML^2/T^2]**,***n—of a tire*, the horizontal force acting perpendicularly to the instantaneous motion vector of the center of contact for a tire operating at a slip angle.

cornering force coefficient [*nd*]**,***n*—the ratio of cornering force to the normal force on a tire.

cornering stiffness [F/γ]**,***n—of a tire*, the negative of the rate of change of tire lateral force with respect to change in tire slip angle, usually evaluated at zero slip angle.

cornering stiffness coefficient, *n—of a tire*, the ratio of tire cornering stiffness to tire normal force.

cornering traction coefficient, *n*—the ratio of the cornering tractive force vector and normal force.

cornering traction vector angle, *n*—the angle between the resultant cornering traction force vector and the *X*' axis.

cornering tractive force [ML^2/T^2]**,***n*—the vectorial sum of lateral and longitudinal tractive force components.

coverstrip, *n*—a thin layer of black compound which covers the unexposed white sidewall portion of a finished tire. **F724**

crazing, *n—on a tire*, minute, closely grouped, generally superficial cracks that usually results from light activated oxidation. **F724**

critical slip angle, (rad or degree)**,***n*—the value of the slip angle at the peak lateral force coefficient.

cross-country track, *n*—surface not subject to repeated traffic in addition, no roads, routes, well-worn trails or man-made improvements; can consist of tank trails with crushed rock or having large exposed obstacles (rocks, boulders, etc.). **F1922**

cupping (also scalloping), *n*—a type of irregular wear characterized by a variation in wear rate that may be periodic (essentially cycloidally shaped) around the tire tread band circumference in one or more rows; the variation of loss is essentially independent of individual projections if the pattern contains these projections. **F1426**

curved equivalent test severity—*in tire testing*, the test conditions (load, rotational speed, tire inflation pressure) on the flat or highway surface that will provide equivalent internal tire temperatures, for example, at the belt edge, to a known set of curved 1.707-m roadwheel surface test conditions. **F2779, F2869**

determination, *n*—the application of the complete measurement procedure to one piece, specimen or object to produce *one* numerical measured value to be used to form an average or median.

developed footprint length [*L*]**,***n*—the maximum footprint dimension in the circumferential direction of the tire, under stated conditions of measurement. **F870**

developed footprint width [*L*]**,***n*—the maximum lateral dimension of a tire footprint under stated conditions of measurement. **F870**

diagonal wear, *n*—a type of irregular wear characterized by an increased wear rate region or band oriented transversely (from shoulder to shoulder) at some non-90° angle with respect to the circumferential centerline of the tire tread band. **F1426**

driving coefficient [*nd*]**,***n*—the ratio of the driving force to the normal force. **F424, F1572, F1805**

driving coefficient, peak[*nd*]**,***n*—the maximum value of the driving coefficient. **F424**

driving force, [*F*]**,** *n—of a tire*, the positive longitudinal force resulting from the application of driving torque. **F424, F1572, F1805**

driving torque [ML^2/T^2] **,** *n—of a wheel*, the positive wheel torque. **F424**

effective rolling radius, *n*—the ratio of the linear velocity of the wheel center of the free rolling tire in the X' direction to the spin velocity. **F424**

element, *n*—an isolated (totally bounded by void) projection. **F421, F762, F870, F1426**

element wear, *n*—a type of irregular wear characterized by an increased wear rate on various, random isolated projections either laterally, longitudinally, or both around the tire with no distinct or repetitive irregular wear pattern. **F1426**

endurance, *n—of a tire*, the ability of a tire to perform as designed in its intended usage conditions such as load, inflation pressure, speed, time, and environmental conditions. **F2779, F2869**

erosion/river wear, *n*—a type of irregular wear characterized by a greater wear rate along the circumferential rib edges next to the major longitudinal grooves; the wear may be wavy in appearance and vary in width around the tire. **F1426**

fastest wearing groove, *n*—the circumferential groove with the minimum life expectancy. **F1016**

fastest wearing location, *n*—that location which exhibits the highest percent tire tread (depth) loss (as calculated in 6.1.1 of Practice F1016). **F1016**

feather wear, *n—in a tire*, a type of element irregular wear characterized by thin strips of rubber extending from the edge of the element. **F1426**

flange, *n*—that part of the rim which gives lateral support to the tire.

flex cracking, *n*—cracking primarily caused by application of mechanical stress-strain cycling. **F724**

footprint area [L^2]**,***n*—the gross contact area of a tire that is loaded (under stated conditions) against a smooth flat surface. **F870**

free rolling tire, *n*—a loaded tire rolling without applied driving or braking torque. **F424**

front end breakaway, *n—in cornering vehicle*, the point in the curved trajectory of a vehicle when it can no longer be maintained on its intended path because of front wheel departure toward the outside of the curve.

full shoulder wear, *n*—a type of row/rib wear characterized by a greater wear rate across the entire shoulder rib to a longitudinal groove, usually on one shoulder of the tire only. **F1426**

g [L/T^2]**,***n*—a unit of acceleration where 1 *g* is equal to the acceleration of gravity, 9.8 m/s^2 (32.2 ft/s^2). **F811**

global testing, *n*—testing conducted at two or more laboratories or test sites for the purpose of comparing candidate tire performance at each location for selected characteristic properties. **E1806**

gravel road, *n*—two lane, all-weather, occasionally maintained, hard or loose surface (for example, large rock, paved, crushed rock, gravel) intended for medium-weight, low-density traffic, in accordance with the U.S. Federal Highway Administration. **F1922**

grooming, *v—in tire testing*, mechanically reworking a snow test surface in order to obtain a surface with more consistent properties. **F1572, F1805**

groove, *n*—a void that is relatively narrow compared to its length. **F414, F421, F762, F870, F1046, F1426, F1922, F1923**

groove, average depth [*L*]**,***n*—the average of all tire groove depth measurements in a single groove. **F421, F762, F1016, F1046**

groove (void) area [L^2]**,***n*—that portion of tire footprint area which is not contacted by ribs or elements. **F870**

groove (void) area fraction [*nd*]**,***n*—the ratio of the groove (void) area to the footprint area of a tire. **F870**

groove (void) depth [*L*]**,***n*—a measurement of the perpendicular distance from a real or calculated reference plane defined by edges of two adjacent ribs (lugs) to the lowest point of contact in the groove (void). **F421, F762, F1046, F1922, F1923**

gyro-stabilized accelerometer, *n*—a precision vertical gyroscope fitted with one to three accelerometers to provide orthogonal measurements referenced to the earth-fixed axis system. **F811**

heel-toe wear, *n*—a type of irregular wear characterized by different wear rates at the leading and trailing edges of a projection (element). **F1426**

high speed performance, *n—of a tire*, the rotational speed capability of a tire to perform as designed in its intended usage conditions such as load, inflation pressure, speed, time, and environmental conditions. **F2779, F2869**

highway equivalent test severity—*in tire testing*, the test conditions (load, rotational speed, tire inflation pressure) on the 1.707-m roadwheel that will provide equivalent internal tire temperatures, for example, at the belt edge, to a known set of highway or flat surface conditions. **F2779, F2869**

hot inflation pressure, *n*—the gauge pressure of a tire after equilibration in an oven, measured between 60 and 80 min after removal from oven. **F2838**

ice, dry, *n*—smooth ice without loose surface materials. **F1572, F1805**

inclination angle, *n—of a tire*, the angle between the *Z*′-axis and the wheel plane. **F424**

inflation gas, *n*—the specific filling medium used to pressurize the tire cavity and maintain a specified gauge pressure (for example, oxygen/nitrogen gas mixture, air). **F2838, F3015**