Designation: F1502 – 05 (Reapproved 2016)

Standard Test Method for Static Measurements on Tires for Passenger Cars, Light Trucks, and Medium Duty Vehicles[1]

This standard is issued under the fixed designation F1502; 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 methods for performing certain mechanical static measurements on tires. The term "static" implies that the tire is not rotating while measurements are being made.

1.2 The values stated in SI units are to be regarded as 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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D2240 Test Method for Rubber Property—Durometer Hardness

F421 Test Method for Measuring Groove and Void Depth in Passenger Car Tires

F538 Terminology Relating to the Characteristics and Performance of Tires

F870 Practice for Tread Footprints of Passenger Car Tires Groove Area Fraction and Dimensional Measurements

F1082 Practice for Tires—Determining Precision for Test Method Standards (Withdrawn 2005)[3]

3. Terminology

3.1 *Definitions:*

3.1.1 *outside diameter, n*—the maximum diameter of a tire when it is mounted and inflated.

3.1.2 *overall width, n*—the maximum cross-sectional width of a tire, including protective or decorative ribs.

3.1.3 *tire weight, n*—the weight of an unmounted tire without tube or flap.

3.1.4 *tread arc width, n*—the length of the arc measured from one extreme of the tread design proper to the opposite extreme; that is, from shoulder to shoulder perpendicular to the circumferential center line.

3.1.5 *tread hardness, n*—the hardness of an element in the tread design as measured by a designated standard gage.

3.1.6 *tread radius, n*—the radius of a circle whose arc best fits the tread surface when the radius template used is held perpendicular to the circumferential center line of an inflated tire.

3.2 For additional definitions of terms used in this test method, refer to Terminology F538.

4. Significance and Use

4.1 Static measurements of tires are important to tire manufacturers, processing engineers, and vehicle design engineers for purposes of commerce (in consumer/vendor agreements) and in tire research and development.

4.2 The procedures are sufficiently detailed to achieve commercially acceptable reproducibility among laboratories and may therefore be used for specification, compliance, or reference purposes.

4.3 Changes attributable to growth after inflation may be obtained by comparing measurements made immediately after inflation with those made 18 to 24 h later.

5. Tire Marking

5.1 For measurements other than weight, the tire shall be marked at six equally spaced locations around the circumference. Starting at the DOT serial, make radial lines from bead to bead, perpendicular to the tread center line, at 60-degree intervals. Number the resulting sections "1" through "6" in a clockwise sequence as viewed from the side containing the serial number.

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[1] This test method is under the jurisdiction of ASTM Committee F09 on Tires and is the direct responsibility of Subcommittee F09.30 on Laboratory (Non-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.

[3] The last approved version of this historical standard is referenced on www.astm.org.

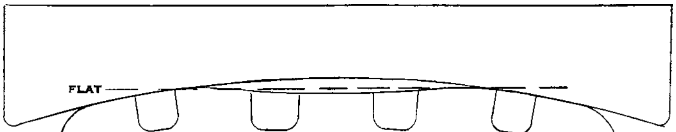

FIG. 1 Type C: Tread Contour with a Center-Low Oxbow

FIG. 2 Outside Diameter Measurement

6. Procedures

6.1 *Tire Weight:*

6.1.1 Weigh the test tire on a scale with accuracy to 0.045 kg (0.1 lb) in the required range. A scale of 0-90 kg (0-200 lb) has been found to be satisfactory for tires within the scope of this test method.

6.1.2 The scale used should be calibrated with weights traceable to the National Institute of Standards Technology (NIST).

6.2 *Outside Diameter:*

6.2.1 Mount the test tire on a rim of the correct diameter for the tire size and the measuring rim width listed for that tire in the current yearbook of the Tire and Rim Association[4] (or applicable document[5,6]), unless another width is chosen.

6.2.2 Inflate the tire to the maximum pressure given on the sidewall unless another pressure has been chosen. Do not exceed the maximum pressure given on the sidewall. Record the value used. Allow 24 h for inflation growth and adjust pressure if necessary.

6.2.3 The assembly of wheel and inflated tire shall be in temperature equilibrium with the environment in which the measurements are to be made. This can usually be achieved in 3 h at room temperature, 24 ± 8°C (75 ± 15°F). Record ambient temperature at the time of measurements.

FIG. 3 Overall Width Measurement

6.2.4 Anchor the end of a "diameter" (pi) tape in the tread center (or other maximum diameter location, that is, center low oxbow (Fig. 1)), at any circumferential location. Use a thumbtack if necessary. See Fig. 2.

6.2.5 Carefully align the tape around the tire circumference so that it is parallel to the plane of the tread center line. Read and record the indicated diameter.

6.3 *Overall Width:*

6.3.1 Mount and condition the test tire as in 6.2.1 – 6.2.3.

6.3.2 Use an outside caliper or other direct-reading device that is graduated in 0.25 mm (0.01 in.). See Figs. 3 and 4.

6.3.3 The measured overall width shall include protective side ribs, bars, and decorations.

6.3.4 Section width can be obtained by subtracting heights of sidewall protuberances from the overall width obtained in 6.3.3.

6.3.5 Record individual and average overall width measurements from 6.3.3 to the nearest 0.25 mm (0.01 in.) from at least three equally spaced circumferential locations as marked in 5.1.

6.4 *Tread Radius:*

6.4.1 Prepare the tire as in 6.2.1 – 6.2.3.

6.4.2 Tread radius templates commonly have radii ranging from 120 mm (4.75 in.) to 300 mm (12.0 in.) in 12.8-mm (0.50-in.) increments and from 300 mm (12.0 in.) to 900 mm (35.5 in.) in 12.8-mm (0.50-in.) increments. Choose the one that most closely fits the tread arc defined by one of the following types of contour. See Fig. 5.

NOTE 1—For tires outside or different from these most popular tread radius contours, that is, extreme low profile types, identify those radii that most closely define the tread contour.

6.4.2.1 *Type A Single (Primary) (see*Fig. 6*)*—This type is characterized by a tread arc that can be uniformly contacted by one of the templates. Choose the one that most closely fits the arc defined by three points, the tread center, and two shoulders. Since a perfectly uniform radius is not always attainable, other typical variations are discussed as means for arriving at a best descriptive fit.

6.4.2.2 *Type B Dual, Drop Shoulder* (see Fig. 7)—This type is characterized by the inability to fit a single-radius template across the entire tread because of drops at the shoulders.

[4] Current yearbook of the Tire and Rim Association available from the Tire and Rim Association, Inc., 175 Montrose Avenue, West, Suite 150, Copley, OH 44321.

[5] Current yearbook of the European Tyre and Rim Technical Organization available from the ETRTO, 32 Avenue Brugmann, 1060 Brussels, Belgium.

[6] Current yearbook of the Japan Automotive Tire Manufacturers' Association Inc. available from JATMA, 8th floor, No. 33 Mori Bldg., 3-8-21 Toranomon Minato-ku, Tokyo, Japan 105-0001.

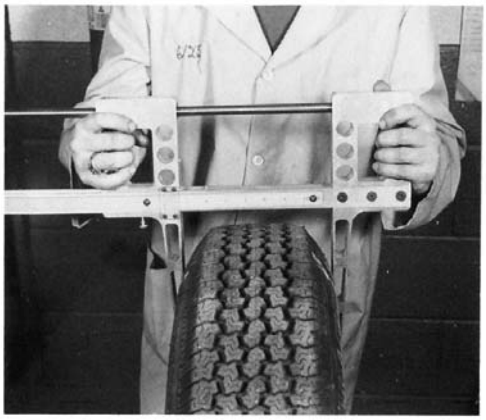

FIG. 4 Overall Width Measurement

FIG. 5 Tread Radius Measurement

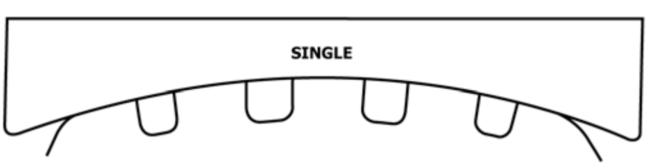

FIG. 6 Type A: Tread Contour with a Single Radius

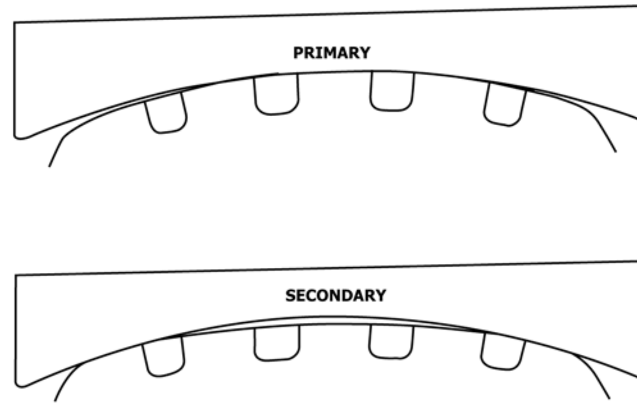

FIG. 7 Type B: Tread Contour with a Dual Radius

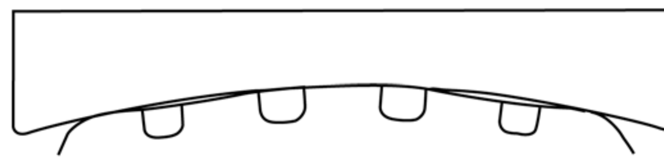

FIG. 8 Type D: Tread Contour with a Center-High Oxbow Style

Choose the one that most closely fits the center portion of the tread, ignoring the shoulder drop. A secondary radius of the shoulders can then be determined to obtain a more complete description of the tread contour.

6.4.2.3 *Type C, Center-Low Oxbow* (see Fig. 1)—This type is characterized by a center contour that drops too low to be fitted by any of the standard templates. This is the only contour type for which the central area is not of prime importance. Choose the template that best fits the intermediate and shoulder areas. Do not confuse Type C with Type B secondary contour as shown in Fig. 7.

6.4.2.4 *Type D, Center-High Oxbow* (see Fig. 8)—This type is characterized by raised center ribs accompanied by a depressed intermediate area and another raised area at the shoulders, so that a gap exists in the mid-point areas. Choose the template that most closely fits the tread center and both shoulders.

6.5 *Tread Hardness:*

6.5.1 Prepare the test tire as in 6.2.1 – 6.2.3.

6.5.2 Mount the tire/wheel unit in a test fixture or stand it on a smooth surface so that its wheel axis is parallel to that surface.

6.5.3 An A-scale durometer hardness gage[7] may be used. Report the brand name of the one chosen.

6.5.4 Make measurements in smooth and flat areas of the six tread sections marked off in 5.1 (see Fig. 9). Avoid placing the probe near sipes, mold vents, or edges of tread elements.

6.5.5 Results on crown and shoulder elements should be recorded separately since they may differ from each other.

6.5.6 Apply the gage rapidly, in a manner prescribed in Test Method D2240, in a direction perpendicular to the tread surface, using enough force to ensure that the gate plate lies flat against the surface.

6.5.7 Hardness readings should be taken quickly, within 1 s after the application of force. Report the average hardness reading, the nearest scale division, for the area measured, that is, crown or shoulder.

6.6 *Tread Arc Width:*

6.6.1 Use a flexible steel scale, such as that shown in Fig. 10, having scale divisions of 2.50 mm (0.10 in.).

6.6.2 Press scale onto the tire tread so that it is perpendicular to the circumferential center line and conforms to the tread arc.

6.6.3 Record, to the nearest scale division, at least one measurement in each of the three chosen sections.

7. Groove (Void) Depths

7.1 Static measurements for groove (void) depths are described in Test Method F421.

[7] Shore and Rex types A-scale durometer hardness gage have been found suitable for this purpose.

FIG. 9 Tread Hardness Measurement

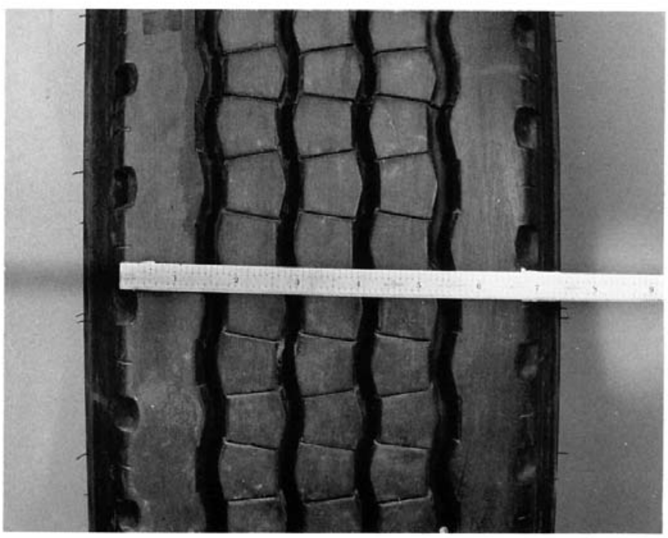

FIG. 10 Tread Arc Width Measurement

8. Gross Footprint Area

8.1 Gross footprint area measurements are described in Test Method F870.

9. Report

9.1 Each examiner taking measurements will need to report the data in a logical format and form. Frequent tire measurements will necessitate that a standard data reporting form be utilized within one's own company.

10. Precision and Bias[8]

10.1 This precision and bias section has been prepared in accordance with Practice F1082. Please refer to this practice for terminology and other statistical calculation details.

10.2 To develop the data for this precision section a P195/75R14 steel belted radial tire with measurement markings was mounted on a 6 × 14 rim and circulated to three laboratories or tire testing company locations, for the various static tire measurements as called for in this test method. At each laboratory, two different technicians made independent static tire measurements on each of two different days spaced one day apart. The word "independent" means that the results of other technicians and the results of the previous day (for the same technician) were not known or available during the measurement process.

10.3 The P195/75R14 tire was not dismounted for weight measurements. An inflation pressure of 26 psi (179 kPa) was used for all static measurements. A test result is defined as a single measurement of the particular static tire dimension or property.

10.4 The results of the precision evaluation are given in Table 1 for the seven static measurements. The results of this table were calculated by the standard procedures as set forth in Practice F1082. The within-laboratory variation expressed by *Sr* (and *r*, *(r)* as well), is a pooled (or root mean square average) value across both technicians in all three laboratories. The between-laboratory variation expressed by *SR* (and *R*, *(R)* as well) is a value that has both a laboratory-to-laboratory component as well as a technician-to-technician component.

10.5 Statements for precision may be made as follows for any static measurement.

10.5.1 *Repeatability*—The repeatability, *r*, of this test measurement has been established as the appropriate value tabulated in Table 1. Two single test results, obtained under normal test method procedures, that differ by more than this tabulated *r*, must be considered as derived from different or non-identical sample populations.

10.5.2 *Reproducibility*—The reproducibility, *R*, of this test measurement has been established as the appropriate value tabulated in Table 1. Two single test results obtained in two different laboratories, under normal test measurement procedures, that differ by more than the tabulated *R*, must be considered to have come from different or non-identical sample populations.

10.5.3 Repeatability and reproducibility expressed as a percentage of the mean level, *(r)* and *(R)*, have equivalent application statements as above for *r* and *R*. For the *(r)* and *(R)* statements, the difference in the two single test results is expressed as a percentage of the arithmetic mean of the two test results (in absolute units).

10.6 In addition to the standard precision calculation procedure as described above, an analysis of variance was conducted (a three-factor ANOVA with laboratories, technicians, and days) to give supplementary information as to the partition of the total variation among the three factors. Table 2 gives the results of that analysis where the percent of the total variation for the three factors is given to the nearest 0.1 %. For tire weight, diameter, and width, 100 % of the variation (to 0.1 %) is the laboratory-to-laboratory component. Tread radius is essentially in this category also. Section width and tread arc width have a substantial technician-to-technician component.

[8] Supporting data for the precision evaluation program of this method have been filed at ASTM International Headquarters and may be obtained by requesting Research Report RR: F09 – 1001.

TABLE 1 Precision Result

NOTE 1—*Sr* = repeatability standard deviation
r = repeatability, (= *Sr* × 2.83), in measurement units
(r) = repeatability in relative (percent) units
SR = reproducibility standard deviation
R = reproducibility, (= *SR* × 2.83), in measurement units
(R) = reproducibility in relative (percent) units

Test	Mean Value, Units	Within Laboratory			Between Laboratory		
		Sr	*r*	*(r)*	*SR*	*R*	*(R)*
Tire weight	39.45 lb	0.0029	0.0082	0.021	0.508	1.438	3.64
	17.91 kg	0.0013	0.0037	0.021	0.231	0.654	3.65
Tire diameter	25.25 in.	0.0058	0.0164	0.065	0.0099	0.028	0.11
	641.4 mm	0.1470	0.4160	0.065	0.2520	0.713	0.11
Tire width	8.00 in.	0.0029	0.0082	0.103	0.0087	0.025	0.31
	203.2 mm	0.0734	0.2077	0.102	0.2200	0.623	0.31
Section width	7.97 in.	0.00	0.00	0.00	0.0115	0.033	0.41
	202.4 mm	0.00	0.00	0.00	0.2920	0.826	0.41
Tread radius	19.67 in.	0.00	0.00	0.00	3.83	10.8	55.1
	499.6 mm	0.00	0.00	0.00	97.30	275.4	55.1
Durometer hardness	76.4 SHORE A	0.38	1.08	1.41	0.52	1.47	1.93
Tread arc width	5.80 in.	0.020	0.057	0.976	0.025	0.071	1.22
	147.3 mm	0.508	1.438	0.976	0.635	1.797	1.22

TABLE 2 Distribution of Variation in Measurement Process (Laboratories, Technicians, Days)

NOTE 1—Values for *Sr* and *SR* are in pounds and inches (durometer hardness excepted).

Test	Percent of Total Variation[A]						
	Laboratories	Technicians	Days	*Sr*	*(r)*	*SR*	*(R)*
Tire weight	100.0	0.0	0.0	0.0029	0.021	0.508	3.64
Tire diameter	100.0	0.0	0.0	0.0058	0.065	0.0099	0.11
Tire width	100.0	0.0	0.0	0.0029	0.103	0.0087	0.31
Section width	50.0	50.0	0.0	0.0000	0.0	0.0115	0.41
Tread radius	99.0	1.0	0.0	0.0000	0.0	3.83	55.1
Durometer hardness	80.0	10.0	10.0	0.38	1.41	0.52	1.93
Tread arc width	40.0	60.0	0.0	0.020	0.98	0.025	1.22

[A] To nearest 0.1 %.

Durometer hardness (which is a visco-elastic or time dependent measurement of modulus) has all three components contributing to the total variation.

10.7 This precision evaluation program had an inadequate number of laboratories for an in-depth evaluation of the testing precision. The precision results are only a first order estimate and future precision evaluation programs should attempt to have at least six laboratories and two or three different types (sizes) of tires.

10.8 *Bias*—In test method terminology, bias is the difference between an average test value and the reference (or true) test property value. Reference values do not exist for this test method since the value (of the test property) is exclusively defined by the test method. Bias therefore cannot be determined.

11. Keywords

11.1 light trucks; medium duty vehicles; passenger car; static measurements; tires