Designation: F 421 – 00

Standard Test Method for Measuring Groove and Void Depth in Passenger Car Tires[1]

This standard is issued under the fixed designation F 421; 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 describes standard procedures for measuring the groove and void depth in passenger car tires.

1.2 Any mechanical, optical, or electronic device capable of measuring groove (void) depth can be used, but only the contact methodology is described here. Noncontact methodology is beyond the scope of this test method.

1.3 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *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:*

F 1082 Practice for Tires—Determining Precision for Test Method Standards[2]

3. Terminology

3.1 *Definitions:*

3.1.1 *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.

3.1.2 *element*, *n*—an isolated (totally bounded by void) projection.

3.1.3 *groove*, *n*—a void that is relatively narrow compared to its length.

3.1.4 *groove average depth, [L], n*—the average of all tire groove depth measurements in a single groove.

3.1.5 *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).

3.1.5.1 *Discussion*—The reader is cautioned that the probe tip used for the depth measurement must have a sufficiently small cross-section compared to the width of the void being measured. The probe must be able to reach the bottom of the void without contacting the tread elements that form the sides of the void.

Special consideration should be given to measuring sipes. (See definition in Terminology F 538.) Since the sipe is substantially narrower than a major groove, a very small diameter probe tip must be used to achieve an accurate measurement of sipe depth.

3.1.6 *irregular wear*, *n*—a type of treadwear characterized by substantial variations of tread loss both from projection to projection and frequently from point to point on a given projection.

3.1.7 *projection*, *n*—a pavement contacting area of the tread band, bounded by void.

3.1.8 *rib*, *n*—a continuous circumferential projection.

3.1.9 *treadwear indicator*, *n*—a raised portion of a groove bottom or void bottom that is molded in a tire at fairly regular intervals around the circumference to provide a visual indication that most of a tread has been worn away.

3.1.10 *uniform wear*, *n*—a type of treadwear characterized by equal tread loss both from projection to projection and from point to point on a given projection, resulting in a smooth appearance of all parts of the tread pattern.

3.1.11 *void*, *n*—a volume (in the tread band) defined by the lack of rubber, the depth dimension of this volume may vary from point to point in (on) the tread band.

4. Summary of Test Method

4.1 This test method gives the detailed procedures and the needed precautions for the measurement of the groove or void depth of the tread pattern in a tire. Calculations for various types of average groove or void depths are given in addition to the required nomenclature for effective communication of the groove or void measurement results.

5. Significance and Use

5.1 The groove (void) depth affects the tire's ability to develop tractive forces on wet pavements, snow, and soil, and its ability to resist hydroplaning. Groove (void) depth also

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[2] *Annual Book of ASTM Standards*, Vol 09.02.

defines the state of wear of a tire and is used in the determination of the rate of wear.

6. Apparatus

6.1 *Gage*, meeting the specifications of the American Gage Design Committee.

6.1.1 The apparatus shall consist of a mechanical or electro-mechanical depth gage fitted with a foot through which a spindle passes. The foot may have any of a variety of shapes, including but not limited to cylindrical, semi-cylindrical, and rectangular. The reference surface of the foot shall be ground planar and perpendicular to the gage spindle. Examples of mechanical gages and typical available gage feet are illustrated in Figs. 1 and 2. A typical electro-mechanical gage system is illustrated in Fig. 3.

6.1.2 The reading of the depth gage shall be accurate to within ± 0.001 in. (0.025 mm) over a range of 1 in. (25 mm). The smallest scale division on the gage shall be at least 0.001 in (0.025 mm).

6.1.3 The gage spindle shall extend at least 1 in. (25 mm) beyond the reference surface of the foot. Spindles may have any of a variety of shapes and diameters suitable for the tread to be measured. Two frequently used spindles are illustrated in Fig. 4.

6.1.4 The spindle shall not touch the side of the hole in the foot.

6.1.5 *Zero Adjustment*— The system shall be adjustable to zero when the foot is pressed against a flat surface. The repeatability on the flat surface shall be within ±20 % of one division (0.0002 in. (0.005 mm)).

6.1.6 The accuracy shall be to within 0.001 in. (0.025 mm) for distances up to 0.5 in. (12.7 mm) and to within 0.005 in. (0.125 mm) for distances from 0.5 to 1 in. (12.7 to 25 mm).

6.1.7 The overall variability for a series of repeated measurements on the flat surface shall be within ±20 % of one division.

6.1.8 Calibration shall be made using gage blocks with dimensions traceable to the National Institute of Standards and Technology primary standard.

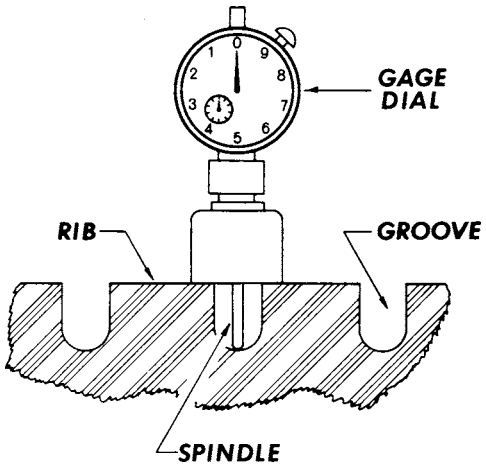

FIG. 1 Illustration of Principle of Method

7. Preparation

7.1 *Gage Zero Adjustment*—Place the foot of the gage against a nondeformable flat surface such as a glass plate and adjust dial to zero.

7.2 *Preparation of Tire*:

7.2.1 Mount the tire on an approved width rim and inflate to the required pressure.

7.2.2 The tire shall be in temperature equilibrium with the environment in which it is measured.

NOTE 1—For purposes of this test method, temperature equilibrium exists if the gage pressure remains within 1 psi (6.9 kPa) of the required inflation pressure during the complete measurement process.

7.2.3 The tire must be dry and free of any foreign material that would interfere with accurate measurement.

7.2.4 Avoid the rubber vents on the tread during measurement or remove them, leaving no projections above the tread surface.

8. Procedure

8.1 *Tires with Uniform Wear*—Place the foot of the gage so that it bridges adjacent ribs or lugs over the area to be measured, avoiding treadwear indicators, and so that the spindle makes perpendicular contact with the groove or void bottom as shown in Fig. 1. This single measurement characterizes the groove (void) depth at this location.

8.2 *Tires Exhibiting Irregular Wear*—Proceed in accordance with 8.1, except the spindle does not have to make perpendicular contact at base of groove as shown in Fig. 2.

9. Characterization of Groove (Void) Depth for the Whole Tire

9.1 The depth of a groove (void) of a tire is characterized by the arithmetic mean of a number of individual measurements.

9.2 *Location of Measurements on Ribbed Tires*:

9.2.1 *Preferred Method*— Make measurements on all ribs or in all grooves.

9.2.2 *Minimum Requirement*—Make measurements on two outer grooves and on either the center groove or, in the absence of a center groove, on the two grooves adjacent to the centerline of the tread.

9.3 *Location of Measurements on Lug Tires*:

9.3.1 *Tires with Tread Width Greater Than 7 in. (178 mm)*—Locate six or seven circumferential lines equally spaced across the tread symmetrically arranged around a line at the center of the tread. The two outer lines shall be within 1 in. (25 mm) of the shoulders.

9.3.2 *Tires with Tread Width Less Than 7 in. (178 mm)*—Locate four or five circumferential lines equally spaced across the tread symmetrically arranged around a line at the center of the tread. The two outer lines shall be within 1 in. (25 mm) of the shoulders.

9.3.3 *Minimum Requirements*—Proceed in accordance with no restriction on tread width.

9.4 *Number of Measurements*:

9.4.1 *Preferred Method*— Ten equally spaced measurements around each rib or circumferential line avoiding treadwear indicators.

NOTE 2—The measurement should be taken at the nearest point along