Designation: F1046 – 01 (Reapproved 2015)

Standard Guide for Preparing Artificially Worn Passenger and Light Truck Tires for Testing[1]

This standard is issued under the fixed designation F1046; 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 guide outlines the preparation of artificially worn tires by tread rubber removal (cutting or grinding, or both) for subsequent performance testing. The purpose is to permit the preparation of test tires with a uniformly reduced tread groove depth and tread geometry that will yield repeatable test results while avoiding the time-consuming and costly over-the-road natural wearing of tires.

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

2. Referenced Documents

2.1 *ASTM Standards:*[2]

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

F762 Test Method for Determining Change in Groove (or Void) Depth With Distance Traveled for Passenger Car Tires

3. Terminology

3.1 *Definitions:*

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

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

3.1.3 *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).

3.1.4 *treadwear indicator, n*—a raised portion of a groove bottom or a 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.

3.1.5 *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 Guide

4.1 This guide outlines a method for groove depth measurement and for reduced groove depth calculation followed by removal of a calculated amount of tread rubber and for final surface grinding to obtain a smooth finish. An optional tire break-in period to follow this operation is described. Techniques for photography and measurements to document the final tread characteristics are described.

5. Significance and Use

5.1 Tires having reduced groove depth are required in some tire tests to determine changes in performance as a tire wears in service. This guide describes the preparation of artificially worn tires. This guide is not meant to replace the development of worn tires through over-the-road travel when naturally worn tires are required. Further refinements of these techniques may be made with increased field experience.

5.2 The amount of tread rubber to be removed (groove depth reduction) and the final surface texture are selected according to the requirements of a particular testing program.

5.3 The type of test program determines the actual tolerance necessary on the final groove depth. For example, snow traction will require very close control of the final groove depth while vehicle handling tests can accommodate a wider tolerance on the final groove depth.

6. Apparatus

6.1 *Tread Depth Gage,* meeting the requirements of Test Method F421.

6.2 *Equipment,* for determining tread radius.

[1] This guide 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.

6.3 *Tire Tread Removal Machine,* with accessories to remove tread rubber in a predetermined manner.

7. Procedure

7.1 *Method Selection*—The actual method utilized determines the accuracy and uniformity of the final groove depth. With equipment monitoring the tread surface relative to the axis of wheel rotation, a tolerance of ±0.51 mm (±0.020 in.) is obtainable with most existing equipment. For other equipment that monitors the tire tread surface or base of the groove, a tolerance of ±2 % groove depth is obtainable.

7.2 *Groove Depth Measurement:*

7.2.1 Mount the tire on a rim approved by the Tire and Rim Association (T & RA)[3] or applicable documents [4,5] for use with the test tire and inflate to maximum rated pressure.

7.2.2 Inspect the tire to determine that there are no tread defects that would affect the finished tire. If such conditions are noted, do not use the tire for this procedure.

7.2.3 Measure sufficient tread groove depths at predetermined distances from the tire centerline to document the original tread depth. Groove measurements are taken at full tread depth, that is, avoiding tie bars, treadwear indicators, and so forth. Average at least four equally spaced measurements in each groove, in accordance with Test Method F762.

7.3 *Rough Tread Cutting:*

7.3.1 Approximately 95 % of the desired groove depth reduction is made on a tire tread removal machine equipped with a rotary electric knife cutter or other suitable device.

7.3.1.1 Move the cutter across the tread surface so as to produce a predetermined tread radius.

7.3.1.2 Control the tire rotation to ensure smooth cutting.

7.4 *Final Grind*—Remove the rough cutting marks so that a smoothed finish is obtained on the tire. The following methods are recommended:

7.4.1 Adapt the tire tread removal machine to an electric grinder.

7.4.1.1 The grinder moves across the tire surface so as to produce a predetermined tread radius.

7.4.1.2 Rotate the tire in a clockwise direction at an appropriate speed.

7.4.1.3 Mount a flat surface grinding wheel on the direct drive motor, rotating in a counterclockwise direction.

7.4.2 Mount the belt sander on the pivot arm allowing 2 degrees of freedom.

7.4.2.1 The operator removes the major "remaining" tread with a medium grade abrasive belt always following the specified tread radius and keeping the belt moving across the tread in a lateral motion to avoid flat spots or ridges.

7.4.2.2 Remove the final few thousandths of rubber with a fine abrasive belt to produce a smooth, matte-like finish.

7.4.3 Any other system which follows original tread contour and tire runout.

7.4.4 If it is critical for the specific test, ensure that the tread element features are consistent and uniform on the entire tread surface. If not, another tire candidate must be prepared.

7.5 *Tire Break-In:*

7.5.1 A vehicle break-in schedule of sufficient travel distance may be included to remove the artificial surface texture left by the finish grinder and simulate, as closely as possible, the surface texture of a naturally worn tire. If it is known that tire break-in will have no effect upon the results of some tests, the break-in requirement may be eliminated.

7.5.1.1 Mark the direction of tire rotation during the break-in on the tire.

7.5.1.2 The amount of break-in required depends on the severity of the driving schedule, road texture, and the surface texture left by tire grinding.

7.5.1.3 After break-in, a tire should have well defined (sharp) rib and element edges, and the profile should not have been changed significantly by rounding off shoulders.

7.5.1.4 The tire break-in schedule should stipulate equal distance for each tire on drive as well as non-drive wheel positions. Record mileages on each wheel position.

7.5.1.5 Maintain tire rotation direction throughout the break-in.

7.5.1.6 Some small additional treadwear will occur if a break-in is used.

8. Calculation

8.1 Calculate target reduced groove depth (50 % illustrated) as follows:

$$\text{Outer groove depth} = A - [0.5(A - h)] \quad (1)$$

$$\text{Center groove depth} = B - [0.5\,(B - h)] \quad (2)$$

where:

A = measured outer groove depth (average),
B = measured center groove depth (average), and
h = treadwear indicator depth defines a 100 % worn tire. (This is normally 1.50 mm (0.063 in.) in passenger car tires.)

8.1.1 The measurement of additional grooves may be necessary on some multi-radius tire designs.

8.2 Calculate reduced tread radius. The new tread radius accounts for a change in tread radius that is caused by removal of a uniform percentage of the tread depth at each groove. More than one radius may be necessary to accurately define the entire revised tread surface. Calculate the reduced tread radius as follows (constant radius illustrated):

$$\theta = S/R \quad (3)$$

$$A = \sin\left(\frac{\theta}{2}\right) \times R \quad (4)$$

$$B = (A/R) \times (R - X) \quad (5)$$

$$C = R - \sqrt{(R - X)^2 - (B)^2 - y} \quad (6)$$

$$r = \frac{B^2 + C^2}{2C} \quad (7)$$

[3] Current yearbook of the Tire and Rim Association, 175 Montrose Ave., West, Suite 150, Copley, OH 44321.

[4] Current yearbook of the European Tyre and Rim Technical organisation. Available from the ETRTD, 32 Avenue Brugmann, 1060 Brussels, Belgium.

[5] Current yearbook of the Japan Automotive Tire Manufacturers' Association, Inc. Available from JATMA, 9th Floor, Toranomon Bldg., 1–12 Toranomon 1–Chrome, Minato-ku, Tokyo, Japan.

where:

S = total arc length between the two outside grooves (inches),
R = new tire tread radius (inches),
X = (desired percent wear) by (new outer groove depth),
y = (desired percent wear) by (new center groove depth), and
r = new radius for worn tire condition.

8.2.1 For multi-radii tire designs, a graphical solution may be necessary based upon a new tire layout drawing or actual inflated tire shoulder to shoulder surface measurements. The final shape can then be graphically determined based on target depth specified.

9. Report

9.1 An enlarged photographic record of the surface condition of the test tires shall be made if requested after final preparation or break-in and prior to testing (see Fig. 1).

9.1.1 Photographs shall be taken at 3 times magnification with the camera mounted perpendicular to the center axis of the tire, as shown in Fig. 2.

9.1.2 Lighting is provided at an angle 30° above a line tangent to the tire surface and perpendicular to the axis of the camera from the direction of travel during the break-in.

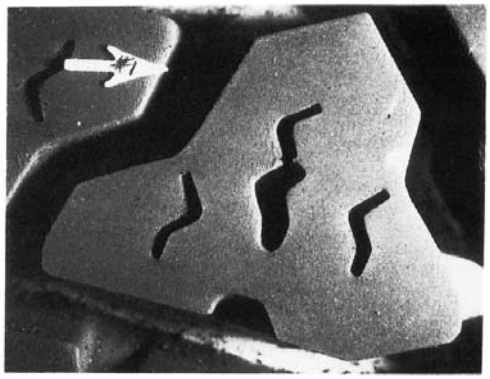
9.1.3 Adjust the light intensity or light distance, or both, for the individual tire size.

9.2 Record, if requested, tire description, tread hardness (Shore A), and tread radius profile. Groove depth measurements before and after groove depth reduction shall be recorded.

10. Precision and Bias

10.1 Quantitative tire performance measurements are not addressed in this guide, therefore precision as normally considered for test method standards is not applicable to this guide.

10.2 Preparation of test specimens is very "technique sensitive," that is, the operator's role in removing rubber and subsequent buffing is critical as is the travel distance and type of break-in on a vehicle. Documentation of the preparation techniques, tire measurements, and photographic evidence of the final tread surface texture are required to obtain comparable artificially worn tires.



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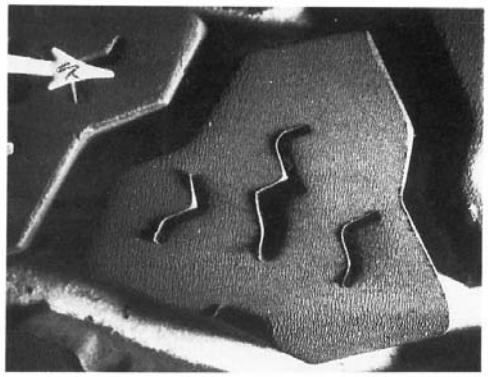

Unacceptable

NOTE 1—Typical reduced groove depth tire surface after tread rubber removal (3× magnification). Break-in will smooth the surface even more.

FIG. 1 Tire Tread Surface Conditions

11. Keywords

11.1 apparatus; artificially worn; light truck tires; passenger tires; preparing; procedure; testing

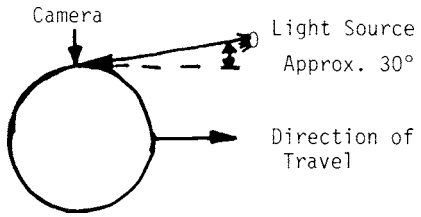

FIG. 2 Set-Up for Photographing Tread Surface Texture