Standard Test Method for Outdoor Evaluation of Tire Sidewall Component Cracking Resistance[1]

This standard is issued under the fixed designation F724; 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 procedures for evaluating passenger car tires for sidewall component integrity and cracking resistance, using an outdoor roadwheel.

1.2 This test method evaluates the resistance of tire sidewalls to dynamic weathering, atmospheric ozone cracking, fatigue cracking, or openings of splices within, or of junctures between, sidewall components and cracking at molded sidewall elements.

1.3 This test method is useful for evaluating tire black sidewalls, white, or other colored, sidewalls, and coverstrips.

1.4 This test method is limited to comparative performance testing between a "control" sidewall component or assembly and one or more experimental alternatives that are built onto the same tire ("multisection") or onto tires that are identical in all respects other than the sidewall variation.

1.5 This test method is not applicable to evaluation of sidewall resistance to abrasion, as may be experienced in severe cornering or curb scuffing.

1.6 The values stated in SI units are to be regarded as the standard.

1.7 *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.* For specific precaution statements, see 5.2.

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D518 Test Method for Rubber Deterioration—Surface Cracking (Withdrawn 2007)[3]
D1149 Test Methods for Rubber Deterioration—Cracking in an Ozone Controlled Environment
D1171 Test Method for Rubber Deterioration—Surface Ozone Cracking Outdoors (Triangular Specimens)
D3395 Test Methods for Rubber Deterioration—Dynamic Ozone Cracking in a Chamber (Withdrawn 2007)[3]
F538 Terminology Relating to the Characteristics and Performance of Tires

3. Terminology

3.1 *Definitions:*

3.1.1 *black sidewall, n*—a sidewall on which only black compounds comprise the outer visible surface of a tire. **F538**

3.1.2 *clinch strip, n*—high-modulus or high-hardness compound applied between the carcass and the sidewall in the bead area to reinforce the bead. **F538**

3.1.3 *coverstrip, n*—a thin layer of black compound that covers the unexposed white sidewall portion of a finished tire. **F538**

3.1.4 *crazing, n*—minute, closely grouped, generally superficial cracks that usually result from light-activated oxidation. **F538**

3.1.5 *flex cracking, v*—cracking primarily caused by application of mechanical stress-strain cycling. **F538**

3.1.6 *juncture, n*—the interface between two different tire components or different compounds within the same component. **F538**

3.1.7 *juncture cracking, n*—a crack with opening originating at a juncture between two components. **F538**

3.1.8 *juncture opening, n*—a separation developing in a juncture. **F538**

3.1.9 *rim strip, n*—a layer of compound, with or without fabric reinforcement, that is applied at the bead to protect the carcass plies against damage from mounting tools and from rim chafing during service. **F538**

[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.

Current edition approved Jan. 1, 2016. Published February 2016. Originally approved in 1981. Last previous edition approved in 2010 as F724 – 94a (2010)$^{\varepsilon 1}$. DOI: 10.1520/F0724-94AR16.

[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.

3.1.10 *sidewall, n—of a tire*, that portion of a tire between the tread and the bead. **F538**

3.1.11 *sidewall component, n*—an individual part of the sidewall construction, either a separate compound or a separately assembled piece. **F538**

3.1.12 *sidewall rubber, n*—the exterior rubber layer of a tire that extends over the sidewall part of the carcass. **F538**

3.1.13 *splice, n*—the joint formed either by overlapping or butting the ends of a given tire component in the course of assembling the tire. **F538**

3.1.14 *splice crack, n*—a crack originating at a splice. **F538**

3.1.15 *splice opening, n*—a parting of a splice along the interface of the assembled ends of a given component. **F538**

3.1.16 *veneer, n*—a thin layer of rubber covering the surface of the tire sidewall. **F538**

3.1.17 *weather cracking, n*—distinct surface cracks induced by action of ozone in those areas of sidewall that are under tension; the cracks usually form perpendicularly to the direction of stress.

3.1.18 *white sidewall, n*—a sidewall that contains a white (or light-colored) compound as a part of the total sidewall. **F538**

4. Significance and Use

4.1 Test Methods D518, D1149, D1171, and D3395 can be used to evaluate different aspects of fatigue and weather cracking resistance of sidewall component materials in the form of test specimens. The present method applies to complete tires that are subjected to actual weather exposure conditions. The present method is satisfactory for research and development purposes but is not applicable to regulatory statutes or purchase specifications until standard classifications of state of cracking, similar to those in Test Method D1171, can be established.

5. Apparatus

5.1 *Outdoor Roadwheel*—An apparatus situated outdoors and consisting of:

5.1.1 One or more smooth steel road wheels of specified diameter. The road wheel(s) shall be wide enough to extend beyond the test tire foot print width. The road wheel diameter shall be no less than 610 mm (24 in.). Smaller diameter wheels may produce excessive flexing and premature extraneous tire failure.

5.1.2 Satellite stations for loading several test tires against the road wheel with known constant force.

5.1.2.1 Each satellite station can individually unload and withdraw the tire from contact with the road wheel in the event of an inflation pressure loss or other potentially catastrophic occurrence.

5.1.2.2 The tire-loading system may be done by any system that provides a constant force to maintain the desired tire deflection throughout the test.

5.1.3 A drive motor that can drive the road wheel(s), within ±1 % of a set test speed for extended periods of time. A commonly used speed is 48 km/h (30 mph).

5.1.4 System for determining accumulated cycles of rotation of each test tire.

5.2 *Safety Precautions:*

5.2.1 The apparatus shall be surrounded by a suitable enclosure to trap tire fragments in the event of a catastrophic failure during the test.

5.2.2 The controls for the apparatus shall be situated outside the enclosure.

6. Sampling

6.1 A sampling plan is not applicable since this test method is intended for research and development testing only. Test specimens (see Section 7) shall be tested simultaneously with a control specimen for direct comparison of relative performance.

7. Test Specimens

7.1 A test specimen shall be a given assembly of sidewall components, specific as to component formulations, assembly cross-section geometry, and preparation procedure. The test specimen may cover the entire sidewall circumference of the test tire and be compared with a control tire or it may cover a section of the sidewall and be compared with a control section and other test specimen sections built onto the same (multisection) tire.

7.2 A test specimen section shall cover ¼ of the circumference of the tire sidewall.

7.3 In multisection tire tests, only specimens on the same side of the tire shall be compared directly.

8. Selection and Preparation of Test Tires

8.1 All test tires shall be approximately the same age and subjected to the same pretest conditions, particularly as related to heat and ultraviolet exposure.

8.2 Multisection test tires shall have been prepared with the test components (for example, varied compounds) having the same cross-sectional profile and dimensions, so as to avoid extraneous mechanical stress variability between the components, unless the profile variation is a test variable.

8.3 The test component surfaces of tires shall be washed with water to remove any temporary protective coating but shall not be subjected to solvent or other surface treatment (in the process of mounting, etc.) that may affect performance unless this is a part of the experimental study.

9. Procedure

9.1 Mount a test tire on a rim contour approved by the Tire and Rim Association[4] for its particular size. For tire-to-tire comparative tests, rims shall be of the same width.

9.2 Mount the tire with the valve at a convenient reference point for describing the locations of cracks or other degradation as they occur.

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[4] Available from the Tire and Rim Association, Inc., Crown Pointe, Suite 150, 175 Montrose West Ave., Copley, OH 44321.

9.3 Inflate the tire to the selected test pressure at ambient temperature. A commonly used inflation pressure is 138 kPa (20 psi). This pressure facilitates the desired deflection of the tire (see 9.4.2) with moderate axle loading.

9.4 Install the tire on the test machine. Give the tire a minute run at full (test) load to ensure that the beads have fully seated. Unload the tire and allow it to return to ambient temperature. Adjust inflation pressure to the selected test pressure. Reload the tire and adjust the load to achieve the specified deflection, while the tire is stationary and in equilibrium with ambient temperature.

9.4.1 Measure deflection by some means accurate to ±1 % of deflection. A useful measuring device and method are described in Annex A1.

9.4.2 Select the deflection to yield a relatively severe sidewall flexing without early durability failure of the tire. Use 30 % deflection for radial tires, 20 % for bias tires. Use lower deflection if the above levels produce early durability failure of tires.

9.5 Run the test tire against the road wheel continuously at the set axle loading associated with the initial inflation, the selected deflection, and selected speed, except for periodic inspection shutdowns.

9.6 Inspections of test tires are made commonly at two-day intervals.

9.6.1 Inspection includes:

9.6.1.1 Close visual (unmagnified) examination of the test component areas for crack initiation and propagation or other degradation development. In a multisection test tire, component performance should not be evaluated within 50 mm (2 in.) of segment junctures.

9.6.1.2 Examination of the tire for extraneous durability problems.

9.6.1.3 Inflation pressure and loaded deflection checks after the tire has cooled to ambient temperature. Air pressure is adjusted if necessary to return to the original cold starting pressure level.

NOTE 1—Cold tire deflections are used. Use of warm (from running) tire deflection is not feasible due to cool down errors when a number of tires are run simultaneously, and they must be measured for deflection sequentially during inspection shutdowns.

9.6.1.4 In the final inspection, measure the inflation pressure for comparison with the original value.

9.7 Test duration is discretionary but generally need not exceed 64 000 km (40 000 miles), which requires 56 to 60 days.

9.8 Data sheet formats for recording test conditions, periodic inspection data, and observations appear in Figs. 1 and 2.

10. Report

10.1 Full description of the tire, including brand, serial number, size, basic construction, and test variable construction features, etc.

10.2 Rim diameter, width and contour.

10.3 Description of test machine and operation conditions:

10.3.1 Road wheel diameter,

10.3.2 Road wheel speed,

10.3.3 Axle load,

10.3.4 Tire inflation pressure, cold starting at ambient temperature,

10.3.5 Loaded tire deflection, cold starting,

10.3.6 Total tire test time and cycles of rotation or equivalent travel distance,

10.3.7 Inclusive dates between which the test was run, and

10.3.8 Specific data characterizing atmospheric conditions, such as ozone concentration, solar radiation, rain, chemical agents, and ambient temperature shall be recorded if available, but are not necessary since the test always involves a control tire or tire multisection(s) running concurrently with the test tires or multisection(s), as the base line for assessing relative performance.

10.4 *Test Results:*

10.4.1 Notations describing the types of flaws initiated (that is, cracks, openings, etc.), their number, and approximate dimensions (length and depth) or qualitative comments if measurements are not feasible.

10.4.2 Elapsed test time and tire cycles of rotation, at which flaws initiated or progressed significantly.

10.4.3 Only major differences in flaw development are significant in comparing relative performance of test specimens. For example, general occurrence of or deep penetration of flaws of a given type in white sidewall A versus essentially no occurrence in white sidewall B.

10.5 Notations of inflation pressure adjustments required during the test.

10.6 Inflated, unloaded tire section width and height before and after test measured at ambient temperature and the original inflation pressure.

11. Precision and Bias

11.1 No statement is made about either the precision or bias of this test method since the result merely states whether there is conformance to the criteria for success specified in this procedure.

12. Keywords

12.1 component; cracking; evaluation; outdoor; resistance; road wheel; sidewall; tire

PROGRAM ______________________________
TIRE BRAND ______________________________
MFG. NAME ______________________ EXP. TIRE NO. ______________
SERIAL NO. ______________________________

TEST INFORMATION MACHINE TEST POS. ______________
SIZE ______________________ RIM SIZE/CONTOUR __________
GENERAL CONSTRUCTION ______________________________
TREAD WING CONSTRUCTION: TOS ______________ SOT ______________
OTHER (multsection construction details, etc.) ______________________
____
____

ROAD WHEEL DIAM. MM (IN) 610 (24) ______________ 1220 (48) __________

TEST CONDITIONS

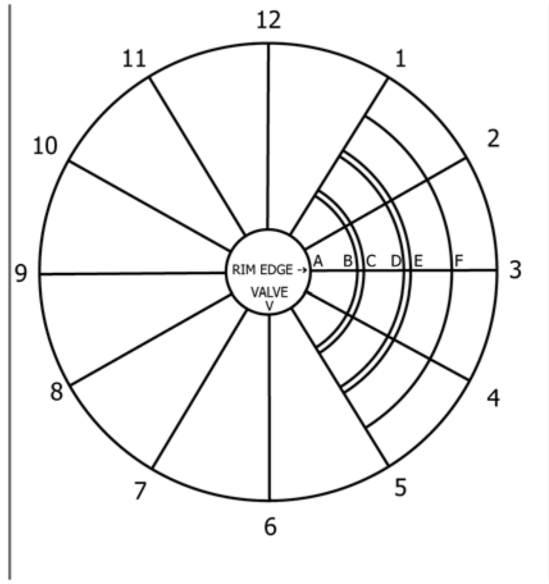
INFLATION PRESS., 138 KPA (20 PSI) OTHER ______________________
TARGET DEFLECTION, % 20 ______ 25 ________ 30 _______ OTHER ________
ROAD WHEEL SPEED, ______________ KM/HR (____________ MI/HR)
AXLE LOAD, ____________ KG
UNLOADED SECTION HEIGHT ______________ MM (___________ IN)
LOADED SECTION HEIGHT ______________ MM (____________ IN)
ACTUAL DEFLECTION ________________ %

TEST DATA

DATE	TEST TIME HOURS	TEST DURATION KC OF TIRE ROTATION		TEMP AMB DEG C	INFLA. KPA* (PSI)	REMARKS
		PERIOD	CUMULATIVE			
						(NOTES KEYING
						TO TIRE
						PERFORMANCE
						OBSERVATIONS)

* TIRE INFLATION TAKEN ON NON-RUNNING TIRE @ AMBIENT TEMPERATURE

FIG. 1 Data Recording Format



EXP. TIRE NO. ____________________
MACHINE POSITION NO. ____________

COLORED SIDEWALL SIDE
MOUNTED ON MACHINE
FACING OUTSIDE _________________
FACING INSIDE ___________________

SIDEWALL CONFIGURATION
DETAILS, DIMENSIONS* ________

A. RIM EDGE
B. LOWER COVER STRIP RECESS EDGE
C. LOWER COLORED SIDEWALL EDGE
D. UPPER COLORED SIDEWALL EDGE
E. UPPER COVER STRIP RECESS EDGE
F. UPPER COVER STRIP EDGE
(A-B) 12 mm
(B-C) 0.45 mm
(C-D) 22 mm
(D-E) 0.45 mm
(E-F) 10 mm

DATE	TEST DURATION (KC)**	INSPECTION NOTES

*Typical features, dimensions shown as examples.
**Kilocycles of tire rotation; other suitable parameters may also be used.

FIG. 2 Data Recording Format

ANNEX

(Mandatory Information)

A1. TIRE DEFLECTION MEASUREMENT METHOD

A1.1 Percent deflection is defined, in accordance with the T & RA Yearbook, as the difference between the loaded and unloaded section heights divided by the unloaded section height above the top of the rim flange, multiplied by 100.

A1.2 Percent deflection is expressed as follows:

$$\%\ \text{Deflection} = \left[\frac{h_u - h_l}{h_u}\right] \times 100 \qquad \text{(A1.1)}$$

where the tire dimensions are as defined in Fig. A1.1.

A1.3 *Tire Deflection Measuring Device*—To measure h_u and h_l, the measuring device in Fig. A1.2 can be used. It is made up of (*1*) an upright member *C* with graduated scales of h_l and h_u, (*2*) a foot bar *B* for contacting the road wheel surface or the tire tread crown, and maintaining the scale piece *C* normal to these surfaces, and (*3*) a probe rod *E* that can be positioned to contact the edge of the rim flange. The foot bar is laterally adjustable in the scale base to reach around the tire sidewall profile to either the tread crown (for h_u measurement) or the tread edge (for h_l). Once adjusted, the foot bar is locked in position by a set screw *A*. The probe is adjustable laterally and vertically to reach the rim flange edge, then is lockable with the set screw *D* and nut *F*.

A1.4 To measure h_u, refer to Fig. A1.2. Select and mark two measurement locations at least 90° apart, where the sidewall is smooth (free of lettering, etc.), and the tread crown register is well matched.

A1.4.1 Adjust the measurement device for maximum lateral extension of the foot bar, over the tire tread crown. Lock the foot bar with set screw *A*.

A1.4.2 Position the device at the first measurement location, with the scale upright lightly touching the tire sidewall. Apply hand pressure to press the foot bar against the center ribs of the tread.

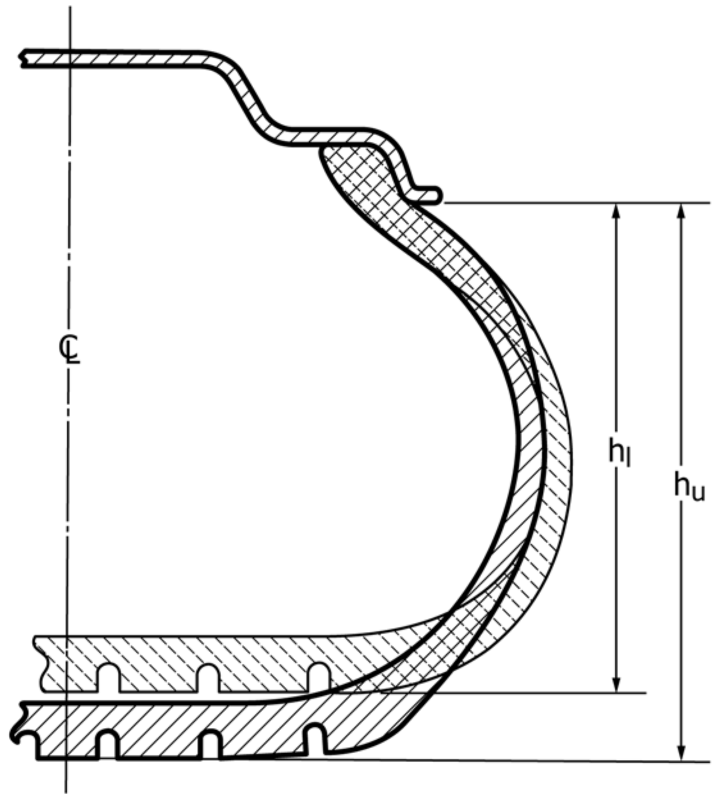


FIG. A1.1 Tire Deflection Parameters

A1.4.3 Adjust the probe rod laterally, and vertically in the scale slot, to lightly contact the outer edge of the rim flange. Lock the probe position.

A1.4.4 Remove the device from the tire and read h_u, the probe distance above the top of the foot, from the h_u scale. Repeat the measurement to confirm the reading.

A1.4.5 Repeat the h_u measurement at the second location.

A1.5 To measure h_l, refer to Fig. A1.2.

A1.5.1 Rotate the tire to place the first measurement location at the center of the road wheel contact area.

A1.5.2 Slightly loosen both locking screws and the probe rod locking nut on measuring device. Position foot bar *B* against road wheel running surface at center of tire contact area; move scale base against the edge of the road wheel to ensure proper alignment. Lock foot bar with screw *A*.

A1.5.3 Adjust probe to lightly contact rim flange outer edge as in the h_u measurement.

A1.5.4 Lock probe rod in position with screw *D* and nut *F*.

A1.5.5 Remove the device from tire and read h_l, the probe point distance above the bottom of the foot bar, from the h_l scale. Repeat the measurement to confirm the reading.

A1.5.6 Rotate the tire to place the second measurement location at the center of the road wheel contact area.

A1.5.7 Repeat the h_l measurement as described in A1.5.2 – A1.5.5.

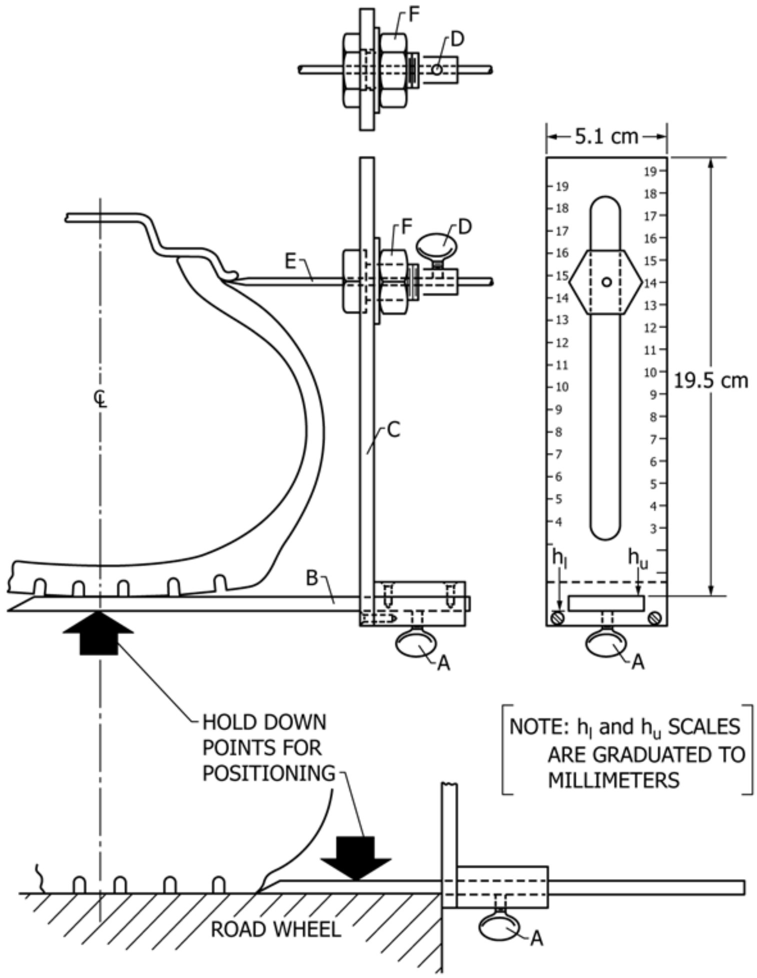


FIG. A1.2 Tire Deflection Measuring Device