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Passenger car tyres — Method for measuring relative wet grip performance — Loaded new tyres

Pneumatiques pour voitures particulières — Méthode de mesure de l'adhérence relative sur revêtement mouillé — Pneumatiques neufs en charge

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Foreword

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For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: Foreword - Supplementary information

The committee responsible for this document is ISO/TC 31, *Tyres, rims and valves*, Subcommittee SC 3, *Passenger car tyres and rims*.

This second edition cancels and replaces the first edition (ISO 23671:2006), which has been technically revised.

Passenger car tyres — Method for measuring relative wet grip performance — Loaded new tyres

1 Scope

This International Standard specifies the method for measuring relative wet grip braking performance index to a reference under loaded conditions for new tyres for use on passenger cars on a wet-paved surface.

The methods developed are meant to reduce variability. The use of a reference tyre is necessary to limit the variability of the testing procedures.

This International Standard applies to all passenger car tyres.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 4000-1, *Passenger car tyres and rims — Part 1: Tyres (metric series)*

ASTM E303-93 (Reapproved 2013), *Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester*

ASTM E501-08, *Standard Specification for Standard Rib Tire for Pavement Skid-Resistance Tests*

ASTM E965-96 (Reapproved 2006), *Standard Test Method for Measuring Pavement Macro texture Depth Using a Volumetric Technique*

ASTM E1136-93 (Reapproved 2003), *Standard Specification for A Radial Standard Reference Test Tire*

ASTM F2493-08, *Standard Specification for P225/60R16 97S Radial Standard Reference Test Tire*

EN 13036-1, *Road and airfield surface characteristics — Test methods — Part 1: Measurement of pavement surface macrotexture depth using a volumetric patch technique*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
test run
single pass of a loaded tyre over a given test surface

3.2
candidate tyre
<set> test tyre (set) that is part of an evaluation programme

3.3
reference tyre
<set> special test tyre (set) that is used as a benchmark in an evaluation programme

Note 1 to entry: These tyres usually have carefully controlled design features to minimize variation.

Note 2 to entry: See ASTM F2493-08 — P225/60R16.

3.4
control tyre
<set> tyre (set) that is part of an evaluation programme; it is an intermediate tyre (set) which is used when the candidate tyre and the reference tyre cannot be directly compared on the same vehicle

3.5
braking force of a tyre
longitudinal force, expressed in newtons, resulting from braking torque application

3.6
braking force coefficient of a tyre
ratio of braking force to vertical load

3.7
peak braking force coefficient of a tyre
maximum value of tyre braking force coefficient that occurs prior to wheel lockup as the braking torque is progressively increased

3.8
lockup of a wheel
condition of a wheel in which its rotational velocity about the wheel spin axis is zero and it is prevented from rotating in the presence of applied wheel torque

3.9
vertical load
normal reaction of the tyre on the road

3.10
tyre test vehicle
dedicated vehicle which has instruments to measure the vertical and the longitudinal forces on one tyre during braking

4 Methods for measuring wet grip

Relative wet grip braking performance for loaded passenger car new tyres travelling straight ahead on a wet, paved surface can be measured by one of the following methods:

— vehicle method consisting of testing a set of tyres mounted on a standard vehicle;

— test method using a trailer or a tyre test vehicle equipped with the test tyres.

5 General test conditions

5.1 Track characteristics

The surface shall have a uniform grade of not more than 2 % and shall not deviate more than 6 mm when tested with a 3 m straight edge.

The test surface shall have a pavement of uniform age, composition, and wear. The test surface shall be free of loose material and foreign deposits.

It shall be a dense asphalt surface.

The maximum chipping size shall be from 8 mm to 13 mm.

The texture depth measured as specified in EN 13036-1 and ASTM E965-96 (Reapproved 2006) shall be (0,7 ± 0,3) mm.

In order to verify the frictional properties of the surface, a) or b) shall be used.

a)   British Pendulum Number (BPN) method

The averaged British Pendulum Number (BPN) [British Pendulum Tester method as specified in ASTM E303-93 (Reapproved 2013) using the pad as specified in ASTM E501-08] shall be between 42 BPN and 60 BPN after temperature correction.

Pad rubber component formulation and physical properties are to be requested.

BPN shall be corrected by the wetted road surface temperature. Unless temperature correction recommendations are indicated by the British pendulum manufacturer, the following formulae can be used:

Temperature correction = $-0,001\,8\,t^2 + 0,34\,t - 6,1$ (1)

BPN = BPN (measured value) + temperature correction (2)

where t is the wetted road surface temperature, in degrees Celsius.

Effects of slider pad wear: The pad shall be removed for maximum wear when the wear on the striking edge of the slider reaches 3,2 mm in the plane of the slider or 1,6 mm vertical to it in accordance with ASTM E303-93 (Reapproved 2013), 5.2.2 and Figure 3.

Checking track surface BPN constancy for the measurement of wet grip on a standard vehicle: To decrease the dispersion of test results, the BPN values of the track should not vary over the entire stopping distance. The operation shall be repeated five times at each point of the BPN measurement. The BPN shall be measured every 10 m on the braking lane and the coefficient of variation of the BPN averages shall not exceed 10 %.

b)   ASTM E1136-93 (Reapproved 2003) Standard Reference Test Tyre method

The average peak braking force coefficient ($\mu_{peak,ave}$) of the ASTM E1136-93 (Reapproved 2003) (see Clause 7) shall be 0,7 ± 0,1 at 65 km/h.

For the trailer method, testing is run in such a way that braking occurs within 2 m of where the surface was examined.

The average peak braking force coefficient ($\mu_{peak,ave}$) of the ASTM E1136-93 (Reapproved 2003) shall be corrected by the wetted road surface temperature:

temperature correction = $0,0035\,(t - 20)$ (3)

peak braking force coefficient ($\mu_{peak,ave}$) = peak braking force coefficient (measured) + temperature correction (4)

where t is the wetted road surface temperature, in degrees Celsius.

5.2   Wetting conditions

The surface can be wetted from the track-side or by a wetting system incorporated in the test vehicle or the trailer.

If "external watering" is used, water the test surface at least half an hour prior to testing in order to equalize the surface temperature and water temperature. External watering should be supplied continuously throughout testing.

For the whole testing area, the water depth shall be between 0,5 mm and 1,5 mm.

5.3   Atmospheric conditions

The wind conditions shall not interfere with wetting of the surface (wind-shields are allowed).

Both the wetted surface and the ambient temperature shall be between

— 2 °C and 20 °C for the snow tyres, and

— 5°C and 35 °C for the normal tyres.

Moreover, the wetted surface temperature shall not vary during the test by more than 10 °C.

The ambient temperature must remain close to the wetted surface temperature; the difference between the ambient and the wetted surface temperature must be less than 10 °C.

5.4   Reference tyre

The specifications of the SRTT, tyre size P225/60R16, are defined in ASTM F2493-08.

6   Measurement of tyre wet grip on a standard vehicle

6.1   Principle

The test method covers a procedure for measuring the deceleration performance of passenger car tyres during braking, using an instrumented passenger car having an Antilock Braking System (ABS).

Starting with a defined initial speed, the brakes are applied hard enough on four wheels at the same time to activate the ABS. The average deceleration is calculated between two defined speeds, with an initial speed of 80 km/h and a final speed of 20 km/h.

6.2   Equipment

6.2.1   Vehicle

Permitted modifications using a standard-model passenger car equipped with an ABS are as follows:

— those allowing the number of tyre sizes that can be mounted on the vehicle to be increased;

— those permitting automatic activation of the braking device to be installed.

Any other modification of the braking system is prohibited.

6.2.2   Measuring equipment

The exposed portions of the system shall tolerate 100 % relative humidity (rain or spray) and all other conditions, such as dust, shock and vibrations, which can be encountered in regular operation.

The vehicle shall be fitted with a sensor suitable for measuring speed on a wet surface and distance covered between two speeds.

To measure vehicle speed, a fifth wheel or non-contact precision (including radar, GPS, etc.) speed-measuring system shall be used.

The following tolerances shall be respected:

— for speed measurement: ±1 % or ±0,5 km/h, whichever is greater;

— for distance: $\pm 1 \times 10^{-1}$ m.

The measured speed or the difference between the measured speed and the reference speed for the test should be displayed inside the vehicle, so that the driver can adjust the speed of the vehicle.

A data acquisition system can be used for storing the measurements.

6.3 Conditioning of the test track

Condition the pavement by conducting at least 10 test runs with tyres not involved in the test programme at 90 km/h (which is higher than the initial test speed to guarantee that a sufficient length of track is conditioned).

6.4 Test speed measurement requirements

The speed at the start of braking shall be (85 ± 2) km/h.

The average deceleration shall be calculated between 80 km/h and 20 km/h.

6.5 Tyres and rims

6.5.1 Tyre preparation and break-in

Trim the test tyres to remove all protuberances on the tread surface caused by mould air vents or flashes at mould junctions.

Fit the test tyres on rims in accordance with ISO 4000-1 using conventional mounting methods. Ensure proper bead seating by the use of a suitable lubricant. Excessive use of lubricant should be avoided to prevent slipping of the tyre on the wheel rim.

Place the fitted test tyres in a location such that they all have the same ambient temperature prior to testing, and shield them from the sun to avoid excessive heating by solar radiation.

For tyre break-in, perform 10 braking runs.

6.5.2 Tyre load

The static load on each front axle tyre shall lie between 60 % and 90 % of the tested tyre load capacity. Tyre loads on the same axle should not differ by more than 10 %.

6.5.3 Tyre inflation pressure

On the front and rear axles, the inflation pressures shall be 220 kPa (for standard load and extra load versions).

Check the tyre pressure just prior to testing at ambient temperature and adjust if required.

6.6 Procedure

First, mount the set of reference tyres on the vehicle.

Accelerate the vehicle in the starting zone up to (85 ± 2) km/h.

The brakes shall always be activated at the same area on the track, and same direction, with a longitudinal tolerance of 5 m and a transverse tolerance of 0,5 m.

According to the type of transmission, two cases are possible.

a) Manual transmission: As soon as the driver is in the measuring zone and having reached (85 ± 2) km/h, release the clutch and depress the brake pedal sharply, holding it down as long as necessary to perform the measurement.

b) Automatic transmission: As soon as the driver is in the measuring zone and having reached (85 ± 2) km/h, select neutral gear and then depress the brake pedal sharply, holding it down as long as necessary to perform the measurement.

Automatic activation of the brakes can also be performed by means of a detection system made of two parts, one indexed to the track and one on board the vehicle. In this case, braking is more severe on the same portion of the track.

If any of the above-mentioned conditions is not met when a measurement is made (speed tolerance, braking time, etc.), the measurement is discarded and a new measurement is made.

For each test and for new tyres, the first two braking measurements are discarded.

After at least three valid measurements have been made, the standard reference tyres (ASTM F2493-08) are replaced by a set of the candidate tyres and at least six valid measurements shall be performed.

A maximum of three sets of candidate tyres can be tested before the reference tyre is re-tested.

EXAMPLE 1   The run order for a test of three sets of candidate tyres (T_1 to T_3) plus a reference tyre R would be the following: R-T_1-T_2-T_3-R

EXAMPLE 2   The run order for a test of five sets of candidate tyres (T_1 to T_5) plus a reference tyre R would be the following: R-T_1-T_2-T_3-R-T_4-T_5-R

6.7   Processing of measurement results

6.7.1   Calculation of the average deceleration, AD

Each time the measurement is repeated, the average deceleration, AD (m·s^{-2}), is the absolute value of:

$$AD = \left| \frac{S_\mathrm{f}^2 - S_\mathrm{i}^2}{2d} \right| \tag{5}$$

where

S_f is the final speed (m·s^{-1});

S_i is the initial speed (m·s^{-1});

d is the distance covered (m) between S_i and the S_f.

6.7.2   Validation of results

For the reference tyre (ASTM F2493-08): If the "coefficient of variation" AD of any two consecutive groups of three test runs of the reference tyre is higher than 3 %, discard all data and repeat the test for all test tyres (the candidate tyres and the reference tyre).

The coefficient of variation is calculated by the following relation:

$$\frac{\text{standard deviation}}{\text{average}} \times 100 \tag{6}$$

For the candidate tyres: The coefficients of variation $\dfrac{\text{standard deviation}}{\text{average}} \times 100$ are calculated for all the candidate tyres. If one coefficient of variation is higher than 3 %, discard the data for this candidate tyre and repeat the test.

6.7.3 Calculation of average, *AD*

If R_1 is the average of the *AD* values in the first test of the reference tyre and R_2 is the average of the *AD* values in the second test of the reference tyre, the following operations are performed, according to Table 1.

Table 1 — Calculation of average, *AD*

Number of sets of candidate tyres between two successive runs of the reference tyre	Set of candidate tyres to be qualified	R_a
1 R_1-T_1-R_2	T_1	R_a = 1/2 (R_1 +R_2)
2 R_1-T_1-T_2-R_2	T_1	R_a = 2/3 R_1 + 1/3 R_2
	T_2	R_a = 1/3 R_1 + 2/3 R_2
3 R_1-T_1-T_2-T_3-R_2	T_1	R_a = 3/4 R_1 + 1/4 R_2
	T_2	R_a = 1/2 (R_1 +R_2)
	T_3	R_a = 1/4 R_1 + 3/4 R_2

T_a (a = 1, 2, etc.) is the average of the *AD* values for a test of a candidate tyre.

R_a is the adjusted *AD* of the reference tyre.

6.7.4 Calculation of braking force coefficient, *BFC*

$BFC(R)$ and $BFC(T)$ are calculated according to Table 2.

Table 2 — Calculation of braking force coefficient, *BFC*

Tyre type	Braking force coefficient, for a braking on the two axles
Reference tyre	$$BFC(R) = \frac{R_a}{g}$$
Candidate tyre	$$BFC(T) = \frac{T_a}{g}$$
NOTE 1 R_a and T_a are expressed in m·s⁻².	
NOTE 2 g is the acceleration due to gravity (rounded to 9,81 m·s⁻²).	

6.7.5 Calculation of the relative wet grip performance index of the tyre

The wet grip index of the tyre represents the relative wet grip performance index of the candidate tyre compared to the reference tyre (ASTM F2493-08).