FINAL
DRAFT

INTERNATIONAL
STANDARD

**ISO/FDIS
23671**

ISO/TC **31**

Secretariat: ANSI

Voting begins on:
2021-02-11

Voting terminates on:
2021-04-08

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

Reference number
ISO/FDIS 23671:2021(E)

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing this document is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 31, *Tyre, rims and valves*.

This third edition cancels and replaces the second edition (ISO 23671:2015), which has been technically revised.

The main changes compared to the previous edition are as follows:

— the method accuracy and reproducibility has been improved by updating the formulae and coefficients for wet grip index calculation;

— the method of track validation has been revised to be done only with 16 in SRTT instead of with BPN or 14 in SRTT,

— the wet grip performance measurement using a control tyre in case of vehicle method has been withdrawn.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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

1 Scope

This document 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 document applies to all passenger car tyres except for:

— special-use tyres marked with "ET";

— T-type temporary spare tyres;

— tyres fitted with additional devices to improve traction properties (e.g. studded 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 E965-96, *Standard Test Method for Measuring Pavement Macro texture Depth Using a Volumetric Technique*

ISO 4223-1:2017, *Definitions of some terms used in the tyre industry — Part 1: Pneumatic tyres*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4223-1 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

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

3.2
braking test
series of a specified number of *test runs* (3.1) of the same tyre repeated within a short time frame

3.3
braking test cycle
series of *braking tests* (3.2) that consist of an initial braking test of the *reference tyre set* (3.6), of up to three braking tests of *candidate tyre sets* (3.5), and a final braking test of the same reference tyre set

3.4
test tyre
tyre that is used for an evaluation programme

3.5
candidate tyre
candidate tyre set
test tyre (3.4) (set) that is part of an evaluation programme and that is evaluated with the reference tyre using the same test method

3.6
reference tyre
reference tyre set
special *test tyre* (3.4) (set) that is used as a benchmark in an evaluation programme

Note 1 to entry: The reference tyre (SRTT) is defined in ASTM F2493.

Note 2 to entry: These tyres have carefully controlled design features to minimize variation.

3.7
braking force
longitudinal force between a tyre and the road resulting from braking torque application

Note 1 to entry: It is expressed in newtons.

3.8
peak braking force coefficient
μ_{peak}
<trailer (or tyre test vehicle) method> maximum value of the *dynamic tyre braking force coefficient* (3.10) that occurs prior to the *lockup of a wheel* (3.12) as the braking torque is progressively increased

3.9
dynamic tyre braking force coefficient
$\mu(t)$
<trailer (or tyre test vehicle) method> ratio between the *braking force* (3.7) and the *vertical load* (3.12) acquired in real time

3.10
average braking force coefficient
BFC
<vehicle method> ratio between the average deceleration in a *test run* (3.1) and the acceleration gravity (9,81 $m \cdot s^{-2}$)

3.11
lockup
condition of a wheel in which its rotational velocity about the wheel spin axis is zero and which prevents it from rotating in the presence of applied wheel torque

3.12
vertical load
normal force of a tyre exerted on the road resulting from the mass supported by the tyre

Note 1 to entry: It is expressed in newtons.

3.13
tyre test vehicle
dedicated vehicle which has instruments to measure the vertical and the longitudinal forces on one tyre during braking

3.14
tyre set
<trailer (or tyre test vehicle) method> set of one tyre

3.15
tyre set
<vehicle method> set of four tyres

4 Methods for measuring wet grip index

For the evaluation of the wet grip index (G) of a candidate tyre, the wet grip braking performance of the candidate tyre is compared to the wet grip braking performance of the reference tyre on a straight, wet, paved surface. It is measured with one of the following methods:

— vehicle method consisting of testing a tyre set mounted on a commercialized vehicle;

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

In case of verification of the wet grip index (G) the same test method used for its declaration shall be used.

NOTE Differently from the previous edition of this document, as far as case of vehicle method is concerned, when the candidate tyre size is significantly different from that of the reference tyre, a direct comparison on the same vehicle may not be possible and the test method using a trailer or a tyre test vehicle can be used.

5 General test conditions

5.1 Track characteristics

The surface shall have a uniform gradient of not more than 2 % in both longitudinal and lateral directions 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 macro texture depth MTD shall be measured as specified in ASTM E965-96 using the area of the track to be used for the wet grip test and shall be (0,7 ± 0,3) mm.

In order to verify the frictional properties of the surface, the reference tyre shall be used as follows.

a) In case of vehicle method: the texture depth is measured in both lanes where the tyres are going to brake.

The temperature-corrected arithmetic mean of the average braking force coefficients (BFC_{corr}) of at least six valid measurements of the reference tyre (see Clause 6) shall be not less than 0,57 and not greater than 0,79.

The arithmetic mean of the average braking force coefficients (BFC_{ave}) of the reference tyre is corrected by the wetted surface temperature as follows:

$$BFC_{corr} = BFC_{ave} + 0{,}002 \frac{1}{°C} \cdot (\vartheta - 20\ °C)$$

where ϑ is the wetted surface temperature in degree Celsius.

Homogeneity of the track friction shall be verified by determining BFC_{corr} values in two braking tests in the same direction with the reference tyre on aligned segments of the track covering the entire

potential braking area, including where the texture depth was measured. The BFC_{corr} of the two braking tests shall not differ by more than 10 % of the average of the two values:

$$2\times\left|\frac{BFC_{corr,1}-BFC_{corr,2}}{BFC_{corr,1}+BFC_{corr,2}}\right|\leq 10\,\%$$

b) In case of method using a trailer or a tyre test vehicle: the temperature-corrected average of the peak braking force coefficients ($\mu_{peak,corr}$) of at least six valid measurements of the reference tyre (see Clause 7) shall be not less than 0,65 and not greater than 0,90 at 65 km/h.

The average of the measured peak braking force coefficients ($\mu_{peak,ave}$) of the reference tyre is corrected by the wetted surface temperature as follows:

$$\mu_{peak,corr}=\mu_{peak,ave}+0{,}002\frac{1}{°C}\cdot(\vartheta-20\ °C)$$

where ϑ is the wetted surface temperature in degree Celsius.

The peak braking force coefficient is measured in the same area where the texture depth was evaluated and the average peak braking force coefficient is evaluated from at least six test runs in the same direction.

5.2 Wetting conditions

The surface may be wetted from the track side ("external watering") or, in case of method using a trailer or a tyre test vehicle, by a wetting system incorporated in the test vehicle or the trailer ("self-watering").

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 both external watering and self-watering systems, for the used braking lanes, the water depth shall be between 0,5 mm and 1,5 mm measured from the peaks of the pavement.

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:

— 5 °C and 20 °C for tyres bearing 3PMSF marking;

— 5 °C and 35 °C for tyres bearing M + S marking without the 3PMSF marking for the wetted surface and between 5 °C and 40 °C for the ambient temperature;

— 12 °C and 35 °C for the tyres bearing neither M + S marking nor 3PMSF marking for the wetted surface and between 12 °C and 40 °C for the ambient temperature.

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.

6 Measurement of tyre wet grip index on a commercialized 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 Anti-lock 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 the initial speed of 80 km/h and the final speed of 20 km/h.

6.2 Equipment

6.2.1 Vehicle

'Instrumented passenger car' means a commercialized-model passenger car equipped with an ABS and the measuring equipment listed in 6.2.2 for the purpose of this testing method.

The age of the car shall be less than five years and its mechanical conditions shall be according to car manufacturer recommendations with no alert from ABS (e.g. warning lights).

Permitted modifications are:

— 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;

— those permitting the vehicle to be guided or accelerated externally.

Any other modification of the vehicle and specifically of the braking system is prohibited.

6.2.2 Measuring equipment

The exposed portions of the measuring system shall tolerate 100 % relative humidity (rain or spray) and all other conditions, such as dust, shock and vibrations, which may 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 a non-contact precision (e.g. radar, GPS) 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 may be used for storing the measurements.

6.3 Conditioning of the test track

Condition the pavement by conducting at least ten 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, rims and fitment on vehicle

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 (or as specified by the appropriate tyre and rim standards organizations) using conventional mounting methods. Rim width code shall not differ more than 0,5 from the measuring rim width code. 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.

The tyres should be stabilized in performance prior to testing, which means that no evolution of the BFC value in test runs should be detectable; in any case there will be an ex-post verification according to 6.6.4. In all cases, tyre designed tread depth and designed tread block or rib integrity shall not change significantly with break-in, which means the pace and "severity" of the break-in need to be carefully controlled to avoid such changes.

Maximum spacers (adapter) width allowed to mount tyres on the vehicle is 60mm.

6.5.2 Tyre load

The static load on each 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 %.

It is prohibited to exceed the maximum axle load of the vehicle.

6.5.3 Tyre inflation pressure

On the front axle, the test inflation pressure p shall be calculated as follows:

$$p = p_{\text{ref}} \times \left(1{,}3 \times \frac{Q}{Q_{\text{ref}}} \right)^{1/\alpha}$$

where

p_{ref} is the reference inflation pressure (250 kPa for standard-load and 290 kPa for extra-load versions, regardless of the reference pressure in the applicable standard);

Q is the average tyre load on the front axle;

Q_{ref} is the reference load capacity according to load index (LI);

α equals 0,8 and is the pressure exponent defined in the applicable standard.

On the rear axle, the inflation pressures shall be 220 kPa (for both standard-load and extra-load versions).

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

6.6 Procedure

6.6.1 Test run

The following applies for each test run.

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 lateral tolerance of 0,5 m.

Braking tests shall occur on the same lanes and in the same direction that were used to examine the surface (with a tolerance of 0,5 m width).

The brakes can be activated either automatically or manually.

The manual activation of the brakes depends on the type of transmission given below.

a) Manual transmission: As soon as the driver is in the measuring zone and having reached (85 ± 2) km/h, disengage 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 is performed by means of a detection system made of two parts, one indexed to the track and one on board the vehicle.

If any of the above-mentioned conditions is not met when a measurement is made (e.g. speed tolerance, longitudinal and lateral tolerance for the braking starting point), the measurement is discarded and a new test run is made.

For each braking test and for tyres not tested before, the first two runs are discarded.

6.6.2 Processing of measurement results

For each test run in conformity with the above conditions, the braking force coefficient BFC is calculated between 80 km/h and 20 km/h as follows:

$$BFC = \frac{v_i^2 - v_f^2}{2 \times d \times g} = \frac{d_0}{d}$$

$$d_0 = \frac{v_i^2 - v_f^2}{2 \times g} = 23{,}596 \text{ m}$$

where

v_f is the final speed ($m \cdot s^{-1}$) = 5,556 $m \cdot s^{-1}$;

v_i is the initial speed ($m \cdot s^{-1}$) = 22,222 $m \cdot s^{-1}$;

d is the distance covered (m) between v_i and v_f;

g is the acceleration due to gravity (rounded to 9,81 $m \cdot s^{-2}$).

6.6.3 Braking test cycle and braking tests

Within the same braking test cycle, each test run of each braking test shall be made in the same direction and in accordance with 6.6.1 and 6.6.2. Several braking test cycles may be performed consecutively,