BS ISO 19447:2021

BSI Standards Publication

# Passenger car tyres — Method for measuring ice grip performance — Loaded new tyres

bsi.

# National foreword

This British Standard is the UK implementation of ISO 19447:2021.

The UK participation in its preparation was entrusted to Technical Committee AUE/4, Tyres and wheels for motor vehicles.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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BS ISO 19447:2021

# INTERNATIONAL STANDARD

# ISO 19447

First edition
2021-09-17

## Passenger car tyres — Method for measuring ice grip performance — Loaded new tyres

*Pneumatiques pour voitures particulières — Méthode de mesurage de l'adhérence sur glace — Pneumatiques neufs en charge*

Reference number
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# Foreword

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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).

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

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.


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# Introduction

The method for measuring ice grip performance described in this document is meant to reduce the variability of the performance measurement. The use of the proper reference tyres limits the variability of the testing method procedures.

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INTERNATIONAL STANDARD ISO 19447:2021

# Passenger car tyres — Method for measuring ice grip performance — Loaded new tyres

## 1 Scope

This document specifies the method for measuring the relative ice grip performance index of a candidate tyre compared with a reference tyre under loaded conditions for new tyres intended to be used for passenger cars on surfaces made of ice.

This document applies to all passenger car tyres, except for T-type temporary-spare tyres.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. 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)*

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

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

## 3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 4000-1 and 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 tyre**
*candidate tyre* (3.3), *reference tyre* (3.4) or *control tyre* (3.5)

**3.2**
**test run**
single pass of a loaded tyre over a given test surface

**3.3**
**candidate tyre**
**T**
*test tyre* (3.1) that is part of an evaluation programme

**3.4**
**reference tyre**
**SRTT**
**R**
special *test tyre* (3.1) that is used as a benchmark in an evaluation programme

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

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# 4 Test methods

## 4.1 Braking on ice method for passenger car tyres

### 4.1.1 General

The ice performance is determined by a test method in which the mean fully developed deceleration of a candidate tyre in an ABS braking test on a flat surface made of ice is compared with that of a reference tyre.

For determination of the ice performance, braking tests of a candidate tyre shall be performed in three non-consecutive braking test cycles.

The relative performance shall be indicated by an ice grip index ($G_I$).

### 4.1.2 Test course

The braking tests shall be done on a flat test surface of sufficient length and width covered with smooth ice with a maximum of 2 % gradient.

The test course surface shall be flat, smooth, polished ice and watered at least 1 h before testing. The water used to make the ice shall be clean and free of any solid inclusions. Before starting the test the braking line should be conditioned by conducting a braking test with tyres not involved in the test programme until the friction level stabilizes. When testing studless tyres, the exact same test line shall be used for all braking test repetitions. When testing studded tyres, the braking lines shall not overlap. The reference tyre shall be tested on its own braking line and the studded tyres next to it on their own individual braking lines. The line for the reference tyre shall be kept clean from ice and snow dust. The studded tyres shall be driven on new clean braking lines.

The surface grip level shall be controlled by measurements with the reference tyre. The average mean fully developed deceleration of the reference tyre shall be not less than 0,9 m/s$^2$ and not greater than 1,6 m/s$^2$ in each braking test.

The air temperature, measured about 1 m above the ground, shall be between −15 °C and +4 °C; the ice temperature, measured on the surface of the conditioned line, shall be between −15 °C and −5 °C. Both air and ice temperatures shall be reported for each tested tyre.

Tests cannot be conducted during snowfall or rainfall or any atmospheric precipitation. It is recommended that direct sunlight, large variations of sunlight or humidity, and wind are avoided.

Indoor and outdoor facilities for ice tracks are acceptable as long as the above requirements are met.

## 4.2 Vehicle

The test shall be conducted with a commercial passenger car equipped with an ABS system in mechanical condition according to car manufacturer recommendations. Permitted modifications 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. Increasing the load on the tyres by adding weight to the vehicle is permitted. Rim adapters or “spacers” for mounting wheels on the vehicle shall not exceed 60 mm.

## 4.3 Standard reference test tyre

For the evaluation of the ice grip performance of passenger car tyres, the reference tyre SRTT P225/60R16 97S as defined in ASTM F2493 shall be used.

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## 4.4 Tyre preparation

### 4.4.1 General

Fit each test tyre on an approved rim in accordance with ISO 4000-1 using conventional mounting methods. The rim width code shall not differ more than 0,5 from the measuring rim. If a commercialized rim is not available for the test vehicle, it will be acceptable to use a rim whose rim width code differs by 1,0 from the measuring rim width code. Ensure proper bead seating with the use of a suitable lubricant. Excessive use of lubricant should be avoided to prevent slipping of the tyre on the wheel rim.

The studless tyres should be broken in prior to testing (at least 100 km on dry roads or with an equivalent method) to ensure stable performance and to remove spew, compound nodules or flash resulting from the moulding process. Studded tyres should be broken in prior to testing (at least 100 km on roads or with an equivalent method) to ensure correct fit of the studs and stable performance. In all cases, tyre designed tread depth and designed tread block or rib integrity shall not change significantly with breaking in, which means the pace and severity of the breaking in run needs to be carefully controlled to avoid such changes. When testing studded tyres, the stud protrusion shall be measured before each braking test according to the procedure described in 4.4.2.

It is acceptable to recondition a test tyre before the braking test. The reconditioning may be performed to reach the stabilized performance level. It can be done, for example, by driving 5 km to 10 km on rough road surfaces or equivalent.

The tyre surface in contact with ice shall be cleaned before performing the test, removing snow and dirt.

Tyre and wheel assemblies shall be conditioned at the ambient temperature (outdoor or indoor, depending on the test facility) at least two hours before they are fitted on the vehicle for tests. Tyre pressures shall then be adjusted to the values specified for the test.

If a vehicle cannot accommodate both the reference and candidate tyres, a third (control) tyre may be used as an intermediate. First, test the control tyre versus the reference on a suitable vehicle, then test the candidate tyre versus the control tyre on the selected vehicle.

### 4.4.2 Stud protrusion measurement procedure

The stud protrusion measurement shall be done under the test inflation pressure conditions. Figure 1 illustrates the stud protrusion device. It shall be equipped with a support plate (2) of 20 mm diameter and 12 mm diameter hole for the measurement head (1). The measurement head shall be pressed perpendicular to the tread surface with a force of 15 N to 20 N to trigger the measurement. The stud protrusion shall be measured from every test tyre, from 20 consecutive studs over the whole width of the tread and in circumferential direction, and at the same stud positions each time. Define in the test report whether tested with or without studs, and accordingly the stud type, name or main dimensions.


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| | Reference tyre | Control tyre | Candidate tyre |
|---|---|---|---|
| **Indirect comparison** | **Vehicle 1**<br>Inflation pressure:<br>230 kPa ≤ $p_{test}$ ≤ 260 kPa<br>Load-on-tyre rate:<br>65 % ≤ $R_{LoT}$(R) ≤ 75 % | **Vehicle 1**<br>Inflation pressure:<br>190 kPa ≤ $p_{test}$ ≤ 270 kPa<br>Load-on-tyre rate:<br>$R_{LoT,1}$(R) − 15 % ≤ $R_{LoT,1}$(C) ≤ $R_{LoT,1}$(R) + 15 % | |
| | | **Vehicle 2**<br>Inflation pressure:<br>190 kPa ≤ $p_{test}$ ≤ 270 kPa<br>Load-on-tyre rate:<br>60 % ≤ $R_{LoT,2}$(C) ≤ 90 % and<br>$R_{LoT,1}$(C) − 15 % ≤ $R_{LoT,2}$(C) ≤ $R_{LoT,1}$(C) + 15 % | **Vehicle 2**<br>Inflation pressure:<br>190 kPa ≤ $p_{test}$ ≤ 270 kPa<br>Load-on-tyre rate:<br>60 % ≤ $R_{LoT}$(T) ≤ 90 % |

Load-on-tyre rate $R_{LoT}$ is given by:

$$R_{LoT} = 100\ \% \times \frac{Q_{tyre}}{Q_{ref}}$$

where

$Q_{tyre}$ is the actual tyre load on the test vehicle;

$Q_{ref}$ is the reference load at the test inflation pressure as determined according to Formula (1).

The reference load $Q_{ref}$ at the test inflation pressure $p_{test}$ is determined according to Formula (1).

$$Q_{ref} = Q_{LI} \times \left( \frac{p_{test}}{p_{ref}} \right)^{0,8} \quad (1)$$

where

$Q_{LI}$ is the maximum tyre load-carrying capacity according to its load index;

$p_{ref}$ is the reference inflation pressure as defined in Table 2.

**Table 2 — Reference inflation pressures**

| Tyre | $p_{ref}$<br>kPa |
|---|---|
| Reference tyre | 250 |
| Light load (LL) and standard load (SL) versions | 250 |
| Reinforced or extra load (XL) version | 290 |

An example of the calculation for the tyre load and inflation pressure conditions can be found in Annex B.

### 4.4.4 Instrumentation

The vehicle shall be fitted with calibrated sensors suitable for measurements in cold and icy conditions. There shall be a data acquisition system to store measurements.

The accuracy of measurement sensors and systems should allow a relative uncertainty of less than or equal to 1 % on the measured or computed mean fully developed deceleration.


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If the mean fully developed deceleration is computed according to Formula (2), for example, the accuracy of the measurements sensors or systems for the measurements of the distance ($s$) and of the speeds ($v_i$ and $v_f$) should be such that the composition of their relative uncertainties, based on Formula (2), allows the mean fully developed deceleration to be determined with a relative uncertainty of less than or equal to 1%.

NOTE Suitable methods for determining the relative measurement uncertainty can be found in ISO/IEC Guide 98-3 .

### 4.4.5 Testing order and braking test cycles

For each braking test of a test tyre, at least nine valid test runs shall be performed.

Within one braking test cycle, up to two candidate tyres may be tested. Several braking test cycles may be combined and the final braking test of the reference tyre of one braking test cycle may serve as the initial braking test of the subsequent braking test cycle.

EXAMPLE 1 For a braking test cycle with two candidate tyres, the order of testing is:

$R_i - T_1 - T_2 - R_f$

where

$R_i$ is the initial braking test of the reference tyre;

$R_f$ is the final braking test of the reference tyre;

$T_1$, $T_2$ are the braking tests of the two candidate tyres to be evaluated.

EXAMPLE 2 The run order for a series of braking test cycles with a total of four candidate tyre sets ($T_1$ to $T_4$) is:

$R_i - T_1 - T_2 - R_f / R_i - T_3 - T_4 - R_f$

where the final braking test of the reference tyre set ($R_f$) of the first braking test cycle serves as initial braking test ($R_i$) of the second braking test cycle.

For any candidate tyre at least three non-consecutive braking test cycles shall be performed.

### 4.4.6 Test procedure

The vehicle shall be fitted on all four positions with the same tyres.

Drive the vehicle in a straight line at a speed about 5 km/h higher than the upper speed of the evaluation interval.

When the measuring zone has been reached, set the vehicle gear into neutral, press the brake pedal sharply down with a force sufficient to cause operation of the ABS on all wheels of the vehicle and to result in a stable deceleration of the vehicle and hold it down until the speed is 0 km/h.

The mean fully developed deceleration $d_m$ shall be determined either between 15 km/h and 5 km/h, or between 20 km/h and 5 km/h. It shall be computed from measurements of either time (expressed in s), distance (expressed in m) or deceleration (expressed in m/s$^2$). For each test run in the braking tests (3 or 4) of a braking test cycle and for all test tyres, the same evaluation speed interval shall be used

### 4.4.7 Data evaluation and presentation of results

#### 4.4.7.1 Data evaluation

For a distance measurement, the mean fully developed deceleration, $d_m$, in a test run is computed using Formula (2):

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$$d_{\mathrm{m}} = \frac{v_{\mathrm{i}}^2 - v_{\mathrm{f}}^2}{2s} \tag{2}$$

where

$v_{\mathrm{i}}$ is the initial speed, expressed in m/s;

$v_{\mathrm{f}}$ is the final speed, expressed in m/s;

$s$ is the distance covered between the initial speed and the final speed, expressed in m.

The highest and the lowest values (in total two runs) of the at least nine valid test runs shall be disregarded in the evaluation of each braking test.

For each braking test in a braking test cycle, the arithmetic mean $d_{\mathrm{m,ave}}$ and the standard deviation $\sigma_d$ of the mean fully developed deceleration and the coefficient of variation $CV_d$ shall be computed and reported according to Formula (3) and Formula (4):

$$\sigma_d = \sqrt{\frac{1}{N-1} \times \sum_{j=1}^{N} \left(d_{\mathrm{m},j} - d_{\mathrm{m,ave}}\right)^2} \tag{3}$$

and

$$CV_d = 100\ \% \times \frac{\sigma_d}{d_{\mathrm{m,ave}}} \tag{4}$$

#### 4.4.7.2 Calculation of the braking test ice grip index

For the calculation of the ice grip index $G_{\mathrm{I},k}(\mathrm{T}_n)$ for an individual braking test, the mean fully developed deceleration of the reference tyre is adjusted according to the positioning of each candidate tyre ($\mathrm{T}_n$) within a braking test cycle.

This adjusted mean fully developed deceleration $d_{\mathrm{m,adj}}(\mathrm{R})$ of the reference tyre is calculated in accordance with Table 3, where $d_{\mathrm{m,ave}}(\mathrm{R_i})$ and $d_{\mathrm{m,ave}}(\mathrm{R_f})$ are the arithmetic means of the mean fully developed decelerations in the initial and the final braking tests, respectively, of the reference tyre within a braking test cycle.


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**Table 3 — Calculation of the adjusted mean fully developed deceleration $d_{m,adj}(R)$ of the reference tyre**

| If the number and the sequence of candidate tyres within one braking test cycle are | and the candidate tyre to be qualified is | the corresponding adjusted mean fully developed deceleration $d_{m,adj}(R)$ of the reference tyre is calculated as follows |
|---|---|---|
| 1 $R_i - T_1 - R_f$ | $T_1$ | $d_{m,adj}(R) = \frac{1}{2} \times [d_{m,ave}(R_i) + d_{m,ave}(R_f)]$ |
| 2 $R_i - T_1 - T_2 - R_f$ | $T_1$ | $d_{m,adj}(R) = \frac{2}{3} \times d_{m,ave}(R_i) + \frac{1}{3} \times d_{m,ave}(R_f)$ |
| | $T_2$ | $d_{m,adj}(R) = \frac{1}{3} \times d_{m,ave}(R_i) + \frac{2}{3} \times d_{m,ave}(R_f)$ |

For an individual braking test, the ice grip index $G_{I,k}(T_n)$ of the candidate tyre $T_n$ ($n$ = 1, 2) relative to the reference tyre is calculated by Formula (5):

$$G_{I,k}(T_n) = \frac{d_{m,ave}(T_n)}{d_{m,adj}(R)} \tag{5}$$

#### 4.4.7.3 Ice grip index

The ice grip index $G_I(T_n)$ of a candidate tyre shall be computed as the arithmetic mean of the ice grip indices $G_{I,k}(T_n)$ for the individual braking tests in the three non-consecutive braking test cycles as per Formula (6):

$$G_I(T_n) = \frac{1}{3} \times [G_{I,1}(T_n) + G_{I,2}(T_n) + G_{I,3}(T_n)] \tag{6}$$

An example of a full test report is given in Annex A.

#### 4.4.7.4 Statistical validation

The sets of mean fully developed decelerations $d_m$ within each braking test shall be examined for normality, drift and eventual outliers.

If the coefficient of variation $CV_d$ of a braking test of a candidate tyre (see 4.4.7.1) exceeds 6 %, this braking test shall be discarded.

In the case of one of the following, the complete braking test cycle shall be discarded:

a) the coefficient of variation $CV_d$ of the initial or the final braking test of a reference tyre within a braking test cycle exceeds 6 %;

b) the arithmetic means of the mean fully developed decelerations of the initial and the final braking test of the reference tyre within a braking test cycle exceeds 5 % of the average of the two values, meaning that the validation coefficient ($C_{val}$) given by Formula (7) shall be less than or equal to 5%.

$$C_{val}(d_m) = 2 \times \left| \frac{d_{m,ave}(R_i) - d_{m,ave}(R_f)}{d_{m,ave}(R_i) + d_{m,ave}(R_f)} \right| \times 100\ \% \tag{7}$$

c) the mean fully developed deceleration of the reference tyre is less than 0,9 m/s$^2$ or greater than 1,6 m/s$^2$ in the initial or the final braking test within a braking test cycle.

For each candidate tyre $T_n$, the coefficient of variation $CV_G$ of the ice grip indices $G_{I,k}(T_n)$ for the individual braking tests in the three non-consecutive braking test cycles shall be calculated according to Formula (8):

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$$CV_G = 100\ \% \times \frac{\sigma_G}{G_{\mathrm{I}}(\mathrm{T}_n)} \tag{8}$$

where

$$\sigma_G = \sqrt{\frac{1}{2} \times \sum_{k=1}^{3} \left[ G_{\mathrm{I},k}(\mathrm{T}_n) - G_{\mathrm{I}}(\mathrm{T}_n) \right]^2}$$

and $G_{\mathrm{I}}(\mathrm{T}_n)$ is the ice grip index of candidate tyre $\mathrm{T}_n$.

If the coefficient of variation $CV_G$ exceeds 6 %, for this candidate tyre $\mathrm{T}_n$ additional braking tests shall be performed in non-consecutive braking cycles, until the coefficient of variation $CV_G$ calculated from any three braking tests of this candidate tyre meets the requirement.

The SRTT tyres shall be discarded if it exhibits irregular wear or damage or when the performance appears to have deteriorated.

#### 4.4.7.5 Ice grip index threshold

A candidate tyre whose ice grip index $G_{\mathrm{I}}(\mathrm{T}_n)$ – determined according to Formula (6) – is equal to or higher than 1,18 is eligible to be labelled, marked or both as an "ice grip tyre".

### 4.4.8 Ice grip performance comparison between a candidate tyre and a reference tyre using a control tyre

#### 4.4.8.1 General

If the candidate tyre cannot be fitted on the same vehicle as the reference tyre, for example, due to tyre size, inability to achieve required load-on-tyre rate and required test inflation pressure, comparison shall be made using intermediate tyres, herein referred to as "control tyres", and two different vehicles.

The control tyre shall pass the ice grip index threshold defined in 4.4.7.5.

One vehicle shall be capable of being fitted with the reference tyre and the control tyre, and the other vehicle shall be capable of being fitted with the control tyre and the candidate tyre.

#### 4.4.8.2 Ice grip index calculation in case of a control tyre

In a first series of three non-consecutive braking test cycles, using the procedure described in 4.4.1 to 4.4.7 in which the control tyre shall be treated as a candidate tyre, the ice grip index $G_{\mathrm{I},1}(\mathrm{C})$ of the control tyre relative to the reference tyre shall be established. In a second series of three non-consecutive braking test cycles, in which the control tyre serves as reference tyre, the ice grip index $G_{\mathrm{I},2}(\mathrm{T})$ of the candidate tyre relative to the control tyre shall be established.

The ice grip index $G_{\mathrm{I}}(\mathrm{T})$ of the candidate tyre relative to the reference tyre shall be calculated, according to Formula (9), as the product of the two ice grip indices:

$$G_{\mathrm{I}}(\mathrm{T}) = G_{\mathrm{I},1}(\mathrm{C}) \times G_{\mathrm{I},2}(\mathrm{T}) \tag{9}$$

#### 4.4.8.3 Boundary conditions

The same set of control tyres shall be used for comparison with the SRTT and the candidate tyre and shall be fitted in the same wheel positions.

Control tyres that have been used for testing shall subsequently be stored under the same conditions as required for the SRTT.


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The SRTT and control tyres shall be discarded if there is irregular wear or damage or when the performance appears to have deteriorated.

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# Annex A
(informative)

# Example of a possible test report of ice grip index for a passenger car tyre

**Part 1 – Report**

1) Testing laboratory: [Name]

2) Name and address of applicant, if applicable: [Name]

3) Test report no.: [YYMMDD-xxxxx-xx]

4) Tyre manufacturer and brand name or trade description: [Name]

5) Tyre class: C1

6) Details of test tyre(s): candidate 1 and, if applicable, candidate 2

   6.1) Tyre size designation(s) and service description(s): [xxx/xx R xx xx{x} x]

   6.2) Tyre brand(s) and trade description(s): [Name]

      6.2.1) Production code(s)/manufacturer's code(s), if applicable: [xxxxxx]

7) Ice index relative to SRTT [x,xx]

   7.1) Test procedure and SRTT used

Procedure: Braking test method according to ISO 19447

SRTT: ASTM F2493, P225/60R16 97S

Production week and year: [xxxx]

8) Comments (if any):

Test tyre is non-studded/studded

Test tyre made in country:

Test tyre production week:

Testing personnel:

9) Date of test report: [DD.MM.YYYY]

10) Signature: _____

[Firstname Lastname]

**Part 2 – Test data: 1st braking test cycle**

1) Date of test: [DD.MM.YYYY]

2) Location of test track: [Name]

   2.1) Test track characteristics:


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| | At start of test | At end of test | Specification |
|---|---|---|---|
| Ambient temperature | | | −15 °C to +4 °C |
| Ice temperature | | | −15 °C to −5 °C |
| Remarks | | | |

3) Test vehicle (make, model and type, year): [Name]

4) Test tyre data:

| | SRTT (initial braking test) | Candidate 1 | Candidate 2 | SRTT (final braking test) |
|---|---|---|---|---|
| Tyre size | | | | |
| Test rim width code | | | | |
| Tyre load (FL/FR/RL/RR) [kg] | | | | |
| Load-on-tyre rate (FL/FR/RL/RR) [%] | | | | |
| Tyre pressure [kPa] | | | | |
| Ambient temperature [°C] | | | | |
| Ice temperature [°C] | | | | |

5) Measured stud protrusions before braking test [mm]

| | Min | Max | Average |
|---|---|---|---|
| Left front | | | |
| Left rear | | | |
| Right front | | | |
| Right rear | | | |

6) Test results: mean fully developed decelerations (m/s$^2$)

| Run number | SRTT (initial braking test) | Candidate 1 | Candidate 2 | SRTT (final braking test) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| | | | | |
| $d_{\mathrm{m,ave}}$ | | | | |
| $\sigma_d$ | | | | |
| $CV_d$ (<6 %) | | | | |
| $CVal(d_{\mathrm{m}})$ (<5 %) | – | – | – | |
| $d_{\mathrm{m,adj}}(R)$ | – | | | – |

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| Run number | SRTT (initial braking test) | Candidate 1 | Candidate 2 | SRTT (final braking test) |
|---|---|---|---|---|
| Ice grip index | 1,00 | | | – |

**Part 2 – Test data: 2nd braking test cycle**

1) Date of test: [DD.MM.YYYY]

2) Location of test track: [Name]

2.1) Test track characteristics:

| | At start of test | At end of test | Specification |
|---|---|---|---|
| Ambient temperature | | | −15 °C to +4 °C |
| Ice temperature | | | −15 °C to −5 °C |
| Remarks | | | |

3) Test vehicle (make, model and type, year): [Name]

4) Test tyre data:

| | SRTT (initial braking test) | Candidate 1 | Candidate 2 | SRTT (final braking test) |
|---|---|---|---|---|
| Tyre size | | | | |
| Test rim width code | | | | |
| Tyre load (FL/FR/RL/RR) [kg] | | | | |
| Load-on-tyre rate (FL/FR/RL/RR) [%] | | | | |
| Tyre pressure [kPa] | | | | |
| Ambient temperature [°C] | | | | |
| Ice temperature [°C] | | | | |

5) Measured stud protrusions before braking test [mm]

| | Min | Max | Average |
|---|---|---|---|
| Left front | | | |
| Left rear | | | |
| Right front | | | |
| Right rear | | | |

6) Test results: mean fully developed decelerations ($m/s^2$)/traction coefficient (strike out what does not apply).

| Run number | SRTT (initial braking test) | Candidate 1 | Candidate 2 | SRTT (final braking test) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |


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| Run number | SRTT (initial braking test) | Candidate 1 | Candidate 2 | SRTT (final braking test) |
|---|---|---|---|---|
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| | | | | |
| $d_{m,ave}$ | | | | |
| $\sigma_d$ | | | | |
| $CV_d$ (<6 %) | | | | |
| $CVal(d_m)$ (<5 %) | – | – | – | |
| $d_{m,adj}(R)$ | – | | | – |
| Ice grip index | 1,00 | | | – |

**Part 3 – Test data: 3rd braking test cycle**

1) Date of test: [DD.MM.YYYY]

2) Location of test track: [Name]

2.1) Test track characteristics:

| | At start of test | At end of test | Specification |
|---|---|---|---|
| Ambient temperature | | | –15 °C to +4 °C |
| Ice temperature | | | –15 °C to –5 °C |
| Remarks | | | |

3) Test vehicle (make, model and type, year): [Name]

4) Test tyre data:

| | SRTT (initial braking test) | Candidate 1 | Candidate 2 | SRTT (final braking test) |
|---|---|---|---|---|
| Tyre size | | | | |
| Test rim width code | | | | |
| Tyre load (FL/FR/RL/RR) [kg] | | | | |
| Load-on-tyre rate (FL/FR/RL/RR) [%] | | | | |
| Tyre pressure [kPa] | | | | |
| Ambient temperature [°C] | | | | |
| Ice temperature [°C] | | | | |

5) Measured stud protrusions before braking test [mm]

| | Min | Max | Average |
|---|---|---|---|
| Left front | | | |
| Left rear | | | |

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| | Min | Max | Average |
|---|---|---|---|
| Right front | | | |
| Right rear | | | |

6) Test results: mean fully developed decelerations ($m/s^2$)/traction coefficient (strike out what does not apply).

| Run number | SRTT (initial braking test) | Candidate 1 | Candidate 2 | SRTT (final braking test) |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |
| 5 | | | | |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| | | | | |
| $d_{m,ave}$ | | | | |
| $\sigma_d$ | | | | |
| $CV_d$ (<6 %) | | | | |
| $CVal(d_m)$ (<5 %) | – | – | – | |
| $d_{m,adj}$(R) | – | | | – |
| Ice grip index | 1,00 | | | – |


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# Annex B
(informative)

# Example of a test conditions calculation to perform an ice grip evaluation test

## B.1 General

This example is aimed at showing in detail the calculation for the tyre load and inflation pressure conditions as referenced in 4.4.3.

Tyre load and test inflation pressure shall be determined based on Table 1 in 4.4.3.

The conditions may be different, when the candidate tyre is directly compared with the reference tyre on the same vehicle or when an indirect comparison is made using a control tyre and another vehicle.

## B.2 Direct comparison

### B.2.1 General

In the direct comparison, it is possible to fit the candidate tyres and the reference tyre on the same vehicle.

### B.2.2 Test vehicle

— Weigh the unladen test vehicle (including the driver).

— Determine the unladen vehicle mass per tyre position ($Q_u$).

— Adjust the vehicle mass and the tyre inflation pressure, respecting the test conditions of Table 1.

### B.2.3 Tyres to be evaluated

The following tyres are to be evaluated on the same test vehicle:

— Reference tyre R: size P225/60R16 SL, LI 97 ($Q_{ref}$ = 730 kg, $p_{ref}$ = 250 kPa).

— Candidate tyre $T_1$: size 195/65R15 XL, LI 95 ($Q_{ref}$ = 690 kg, $p_{ref}$ = 290 kPa).

— Candidate tyre $T_2$: size 215/55R16 XL, LI 97 ($Q_{ref}$ = 730 kg, $p_{ref}$ = 290 kPa).

— Candidate tyre $T_3$: size 195/65R15 SL, LI 91 ($Q_{ref}$ = 615 kg, $p_{ref}$ = 250 kPa).

### B.2.4 Determination of the test conditions

The reference load $Q_{ref}$ at the test inflation pressure $p_{test}$ is determined according to Formula (1) in 4.4.3.

According to Table 1, the permitted test inflation pressure for the reference tyre shall be between $p_{test,min}$ = 230 kPa and $p_{test,max}$ = 260 kPa, and for the candidate tyres between $p_{test,min}$ = 190 kPa and $p_{test,max}$ = 270 kPa.

Taking into account the permitted ranges for test inflation pressures, select suitable test inflation pressures $p_{test}$ for the reference tyre and the candidate tyres.

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Using the selected test inflation pressure, calculate for each test tyre the reference load $Q_{ref}$ according to Formula (1) in 4.4.3.

Load the test vehicle so that for each tyre position the resulting tyre load $Q_{tyre}$ is greater than or equal to the tyre load $Q_u$ in unladen condition and less than or equal to the load resulting from the product of the maximum load-on-tyre rate and the reference load $Q_{ref}$ of the tyre at the test inflation pressure.

Check if the actual tyre load $Q_{tyre}$ fulfils the permitted load-on-tyre rate range for the reference tyre (65 % to 75 %) and for each of the candidate tyres at the selected inflation pressure (SRTT load-on-tyre rate ± 15 %).

If any of the above test conditions are not met, adjust the inflation pressure $p_{test}$, the actual tyre load $Q_{tyre}$ or both.

All relevant tyre specifications, test restrictions (inflation pressures and load-on-tyre rates) and calculations are summarized in Table B.1.


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**Table B.1 — Summary of test condition calculation**

| Vehicle tyre position | | | LF | RF | LR | RR | LF | RF | LR | RR | LF | RF | LR | RR | LF | RF | LR | RR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Tyre load at unladen vehicle conditions | $Q_u$ | kg | 500 | 505 | 515 | 510 | 500 | 505 | 515 | 510 | 500 | 505 | 515 | 510 | 500 | 505 | 515 | 510 |
| SRTT/candidates | | | SRTT | | | | Candidate $T_1$ | | | | Candidate $T_2$ | | | | Candidate $T_3$ | | | |
| Tire size | | | P225/60R16 | | | | 195/65R15 | | | | 215/55R16 | | | | 195/65R15 | | | |
| Standard load or extra load | SL or XL | | SL | | | | XL | | | | XL | | | | SL | | | |
| Tyre load index | LI | | 97 | | | | 95 | | | | 97 | | | | 91 | | | |
| Load-carrying capacity LI | $Q_{LI}$ | kg | 730 | | | | 690 | | | | 730 | | | | 615 | | | |
| 250 kPa for SL,290 kPa for XL | $p_{ref}$ | kPa | 250 | | | | 290 | | | | 290 | | | | 250 | | | |
| Allowed inflation pressure range | $p_{test,min}$ | kPa | 230 | | | | 190 | | | | 190 | | | | 190 | | | |
| | $p_{test,max}$ | kPa | 260 | | | | 270 | | | | 270 | | | | 270 | | | |
| Test inflation pressure (230 kPa to 260 kPa for SRTT, 190 kPa to 270 kPa for other candidates) | $p_{test}$ | kPa | 260 | | | | 240 | | | | 230 | | | | 240 | | | |
| Load capacity at test inflation pressure: $Q_{ref} = Q_{LI} \times (p_{test}/p_{ref})0{,}8$ | $Q_{ref}$ | kg | 753 | | | | 593 | | | | 606 | | | | 595 | | | |
| Actual load ($Q_{tyre}$) per tyre position ($Q_{tyre} \geq Q_u$) | $Q_{tyre}$ | kg | 564 | 555 | 560 | 555 | 505 | 510 | 520 | 515 | 505 | 510 | 520 | 515 | 505 | 510 | 520 | 515 |
| Load-on-tyre rate ($RLoT$) at selected inflation pressure (min and max values) | $R_{LoT,min}(T) = R_{LoT}(R) - 15\ \%$ | % | 65 % | | | | 60 % | 59 % | 59 % | 59 % | 60 % | 59 % | 59 % | 59 % | 60 % | 59 % | 59 % | 59 % |
| | $R_{LoT,max}(T) = R_{LoT}(R) + 15\ \%$ | % | 75 % | | | | 90 % | 89 % | 89 % | 89 % | 90 % | 89 % | 89 % | 89 % | 90 % | 89 % | 89 % | 89 % |
| $R_{LoT} = Q_{tyre}/Q_{ref}$ | $R_{LoT}$ | % | 75 % | 74 % | 74 % | 74 % | 85 % | 86 % | 88 % | 87 % | 83 % | 84 % | 86 % | 85 % | 85 % | 86 % | 87 % | 87 % |

**Key**

LF left-front

LR left-rear

RF right-front

RR right-rear

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## B.3 Indirect comparison

In the indirect comparison, two different vehicles shall be used to compare the ice performance of the control tyre with the reference tyre and to compare that of the candidate tyres with the control tyre.

Use the same methodology as described in Clause B.1 to determine the test conditions for each test vehicle.


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