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Passenger car tyres — Methods for measuring rolling circumference — Loaded new tyres

Pneumatiques pour voitures particulières — Méthodes de mesure de la circonférence de roulement — Pneumatiques neufs en charge

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards 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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 17269 was prepared by Technical Committee ISO/TC 31, *Tyres, rims and valves*, Subcommittee SC 3, *Passenger car tyres and rims*.

Annex A of this International Standard is for information only.

Passenger car tyres — Methods for measuring rolling circumference — Loaded new tyres

1 Scope

This International Standard specifies two methods for measuring, under loaded conditions, the rolling circumference and revolutions per unit distance (kilometres) of new tyres for use on passenger cars. The first is a drum method that consists of loading a test tyre mounted on a free axle against a driven road wheel, or drum, of specified diameter. The second involves using a vehicle whose drive axle is equipped with the test tyres driven on a straight, paved road.

This International Standard is applicable to all passenger car tyres. However, the values obtained from the measurements are not intended to be used as benchmarks for performance or quality.

2 Normative reference

The following normative document contains provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent edition of the normative document indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

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

3 Terms and definitions

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

3.1
revolutions per unit distance
number of tyre revolutions, and parts of revolutions, that occur when the (axle) centre of the tyre is moved a unit distance of exactly 1 km; the number of tyre revolutions per kilometre is calculated as one divided by the tyre rolling circumference (in millimetres) multiplied by 10^6

3.2
rolling circumference of tyre
C_r
distance covered by the tyre during one complete revolution

4 Drum method

4.1 Principle

A test tyre mounted on a free axle is loaded against a driven road wheel (drum) of specified diameter. The value of the rolling circumference is determined for a specified speed, the tyre and drum revolutions are counted and used in the formula, and the formula then used to determine the tyre's rolling circumference.

4.2 Test drum specifications

4.2.1 Diameter

The test drum shall have a diameter of at least 1,20 m, with a free axle capable of holding and loading a tyre against the driven drum. Care shall be taken to avoid galloping during measurements.

4.2.2 Surface

The surface of the drum should preferably be of smooth steel. In cases where a textured drum surface is used, this shall be noted in the test report. The surface of the drum shall be kept clean.

4.2.3 Width

The width of the drum test surface shall exceed that of the test tyre tread.

4.3 Thermal environment

The test should preferably be carried out at a reference room temperature of 25 °C. However, it may be performed in the range 20 °C to 30 °C. No temperature correction is required.

4.4 Speed

In order to establish a basic reference for rolling circumference for all tyres, the drum velocity shall be 80 km/h.

For radial tyres, linear assumption is allowed for the relation between rolling circumference values and the speed of the tyre in the range 80 km/h $\pm$ 50 km/h, and the rolling circumference may be evaluated at 80 km/h by linear interpolation within that range.

4.5 Accuracy

The minimum number of impulses (N_i) per revolution of both the tyre and the drum shall be 10. The total number of impulses during the time of measurement should be greater than 1 000.

4.6 Test tyre parameters

4.6.1 Load

The standard test loads shall be computed from 80 % of the load capacity, corresponding to the load index (LI) moulded on the tyre sidewall, or 80 % of the maximum permissible load.

Load application shall be kept normal to the test surface and shall pass within 5 mrad of the wheel centre.

4.6.2 Alignment

4.6.2.1 Slip angle

The plane of the tyre shall be parallel, within 3 mrad, to the direction of the test surface motion.

4.6.2.2 Camber angle

The plane of the wheel shall be normal, within 10 mrad, to the test surface.

4.7 Inflation pressure

The inflation pressure of the test tyre at ambient temperature shall be 30 kPa less than the reference pressure for the tyre categories specified in annex B of ISO 4000-1:2000. The pressure may be either regulated or capped. For tyres not specified in ISO 4000-1, the reference inflation pressure shall be that given by the tyre manufacturer.

4.8 Rims

The rims used in the test should be of a size and type approved by the tyre manufacturer for use with the test tyres in highway service. If such rims are not available, or the information is unknown, a standard measuring rim, or the rim nearest to it, shall be used in the test.

4.9 Procedure

a) To ensure repeatability of measurements, an initial break-in and cooling period can be necessary prior to the start of the test. Carry out this break-in on a test drum of at least 1,20 m, for a period of not less than one hour, at a minimum velocity of 80 km/h, and at the load and inflation pressure specified in 4.6.1 and 4.7.

b) For future comparisons, record the overall diameter of the new tyre after the break-in.

c) Allow the tyre to stand, inflated, in the test area thermal environment in order for it to achieve thermal equilibrium, generally reached after 3 h.

d) Adjust the inflation pressure to that specified in 4.7. and after about 10 min, verify the load is as specified in 4.6.1.

e) Rotate the drum at the test speed for approximately 30 min to warm up the tyre. After warm-up, the inflation pressure may not be readjusted under capped-pressure conditions, and the test shall be run with pressure build-up to simulate normal service conditions. The values obtained under regulated pressure conditions will be similar to those obtained using capped pressure.

4.10 Calculation

4.10.1 Record the number of revolutions and parts of revolutions of the drum occurring during a time duration, T, taking care to ensure that, for both tyre and drum, the total number of impulses during T is greater than 1 000.

4.10.2 Calculate the test tyre's rolling circumference, C_r, in millimetres, using the formula:

$$C_r = 2\pi \left(\frac{N_d}{N_t} \right) R$$

where

N_d is the number of revolutions of the drum;

N_t is the number of revolutions of the tyre;

R is the radius of the drum, in millimetres.

4.10.3 Results obtained with different drum diameters can be compared using the following empirical formula:

$$C_{\mathrm{r},\,R02} \cong K \times C_{\mathrm{r},\,R01}$$

with

$$K = \left(\frac{(R_1/R_2)(R_2 + r_\mathrm{T})}{(R_1 + r_\mathrm{T})} \right)^{-1/30}$$

where

R_1 is the radius of drum 1, in millimetres;

R_2 is the radius of drum 2, in millimetres;

r_T is the nominal tyre radius, in millimetres;

$C_{\mathrm{r},\,R01}$ is the rolling circumference measured on drum 1, in millimetres;

$C_{\mathrm{r},\,R02}$ is the rolling circumference measured on drum 2, in millimetres.

4.10.4 Results obtained using the formula given in 4.10.2 can be correlated with those obtained by road simulation on a flat surface, which is carried out using the following empirical formula:

$$C_{\mathrm{rF}} \cong K \times C_{\mathrm{rD}}$$

with

$$K = \left(\frac{R_1}{R_1 + r_\mathrm{T}} \right)^{-1/30}$$

where

R_1 is the radius of drum 1, in millimetres;

r_T is the nominal tyre radius, in millimetres;

C_{rD} is the rolling circumference measured on the drum, in millimetres;

C_{rF} is the rolling circumference measured on a flat surface, in millimetres.

5 Test method using vehicle

5.1 Principle

This method consists of driving a typical vehicle whose drive axle is fitted with the test tyres at a constant speed on a straight, level, paved road, and counting the number of tyre revolutions, or parts of revolutions, that occur during the traversal of an accurately measured distance.

5.2 Conditions

5.2.1 Course

The test course shall be a level, straight section of smooth, dry road, whose surface is of either asphalt or concrete pavement of medium roughness. The maximum longitudinal and transverse gradient of the road shall be 1 %. The length of the course should preferably be 500 m, but may be longer depending on the accuracy of the test equipment (see 5.4).

The length of the test course, expressed in metres, shall be measured to within 0,1 %.

There shall be an approach road at both ends of the test course to allow the course to be entered at the test speed.

5.2.2 Weather

The ambient temperature shall be between 5 °C and 30 °C. However, any asphaltic surface shall be sufficiently cool so that the surface is not tacky. The wind speed shall not exceed 7 m/s.

5.3 Speed

The test speed shall be in the range 80 km/h ± 2 km/h.

For radial tyres, linear assumption is allowed for the relation between rolling circumference values and the speed of the tyre in the range 80 km/h ± 50 km/h.

5.4 Accuracy

The minimum number of impulses per revolution shall be 16. The overall error in the revolution-counting equipment, including start and stop errors, shall not exceed 0,1 %.

5.5 Vehicle

The test vehicle shall be representative of the size of vehicle normally fitted with tyres the same size as those being tested.

Because most speedometers and odometers are actuated from the drive-shaft, the test tyres shall be fitted to the drive axle. For four-wheel drive vehicles, one or the other of the drive axles shall be disengaged during the test.

5.6 Test tyre and rim parameters

5.6.1 Tyres

The tyres shall be a matched set of the same size, designation, type and brand, having inflated, unloaded overall diameters within 0,5 % of each other.

For future comparisons, record the overall diameter of the new tyres, measured according to ISO 4000-1.

5.6.2 Load

The load on the drive axle shall be 80 % of the maximum rated tyre load multiplied by the number of tyres on the axle, to within ± 2 %.

The tyres' maximum load capacity corresponds to the LI moulded on the sidewall of the tyre. If this is not marked, use the maximum permissible tyre load capacity.

5.6.3 Inflation pressure

The inflation pressure of the test tyres at ambient temperature shall be 30 kPa less than the reference pressure for the tyre categories specified in annex B of ISO 4000-1:2000. For tyres not specified in ISO 4000-1, the reference inflation pressure shall be that given by the tyre manufacturer.

5.6.4 Rims

The rims used in the test should be of a size and type approved by the tyre manufacturer for use with the test tyres in highway service. If such rims are not available, or the information is unknown, a standard measuring rim, or the rim nearest to it, shall be used in the test.

5.7 Procedure

a) Prior to the test, break in and condition the tyres by running for at least half an hour at an average speed of approximately 80 km/h at the specified load and inflation pressure.

b) Immediately after conditioning, run the test at the speed and on the course specified.

c) Limit acceleration, braking, and steering to an absolute minimum during the measurements.

d) Record the number of revolutions, and parts of revolutions, of the right and left test wheels, during the time taken for the vehicle to complete the test course.

e) Repeat the test twice in both directions. If the number of revolutions for each wheel on the second run differs from the first in the same direction by more than 0,2 %, repeat the test until two runs are obtained in each direction within this tolerance.

5.8 Calculation

5.8.1 Calculate for each of the eight readings (i.e. four runs for each drive wheel) according to 4.3.9 e) and average the eight calculations to obtain the rated value.

5.8.2 To determine the rolling circumference, divide the test course length (in metres) by the number of revolutions measured and multiply this by 10^3. Round this value to the nearest unit.

Annex A
(informative)

Test equipment tolerances

These limits are given in order to achieve suitable levels of repeatable test results that can be correlated among various test laboratories. The tolerances are not intended to represent a complete set of engineering specifications for test equipment, but to serve as guidelines for achieving reliable test results.

Excluding perturbations induced by non-uniform tyres and rims, the test equipment should be capable of checking the test variables within the following limits:

— tyre loading: ± 50 N;

— inflation pressure: ± 5 kPa;

— surface velocity: ± 0,5 km/h;

— drum measurement accuracy: ± 1 mm;

— tyre angular velocity: ± 0,2 %.

Bibliography

[1] ISO 10191, *Passenger car tyres — Verifying tyre capabilities — Laboratory test methods*.

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

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