INTERNATIONAL STANDARD

ISO 18164

First edition
2005-07-01

Passenger car, truck, bus and motorcycle tyres — Methods of measuring rolling resistance

Pneumatiques pour voitures particulières, camions, autobus et motocycles — Méthodes de mesure de la résistance au roulement

Reference number
ISO 18164:2005(E)

ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
Web 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 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 2.

The main task of technical committees is to prepare International Standards. 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 document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18164 was prepared by Technical Committee ISO/TC 31, *Tyres, rims and valves*.

This first edition represents a compilation of three individual standards (ISO 8767:1992, ISO 9948:1992 and ISO 13327:1998) into a consolidated, technically revised single document.

Passenger car, truck, bus and motorcycle tyres — Methods of measuring rolling resistance

1 Scope

This International Standard specifies methods for measuring rolling resistance, under controlled laboratory conditions, for new pneumatic tyres designed primarily for use on passenger cars, trucks, buses and motorcycles. The relationship between values obtained and the fuel economy of the vehicle is undetermined, and such values are not intended to be used to indicate levels of performance or quality.

This International Standard applies to all passenger car, truck, bus and motorcycle tyres.

Measurement of tyres using this method enables comparisons to be made between the rolling resistance of new tyres when they are free-rolling straight ahead, in a position perpendicular to the drum outer surface, and in steady-state conditions.

In measuring tyre rolling resistance, it is necessary to measure small forces in the presence of much larger forces. It is, therefore, essential that equipment and instrumentation of appropriate accuracy be used.

2 Normative references

The following referenced documents are indispensable for the application 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 4223-1:2002, *Definition 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.

3.1
rolling resistance
F_r
loss of energy (or energy consumed) per unit of distance travelled

NOTE The SI unit conventionally used for the rolling resistance is the newton metre per metre (N·m/m).This is equivalent to a drag force in newtons (N).

3.2
rolling resistance coefficient
C_r
ratio of the rolling resistance, in newtons, to the load on the tyre, in newtons

3.3
capped inflation
process of inflating the tyre and allowing the inflation pressure to build up, as the tyre is warmed up while running

3.4
regulated inflation
process of inflating the tyre to the required pressure independent of its temperature, and maintaining this inflation pressure while the tyre runs under load

NOTE This is most commonly done by using a regulated pressure source attached to the tyre through a rotating union.

3.5
parasitic loss
loss of energy (or energy consumed) per unit distance excluding internal tyre losses, and attributable to aerodynamic loss of the different rotating elements of the test equipment, bearing friction and other sources of systematic loss which may be inherent in the measurement

NOTE Depending on the method used, the aerodynamic loss of the tyre may or may not be included in the parasitic loss.

3.6
skim test reading
type of parasitic loss measurement, in which the tyre is kept rolling, without slippage, while reducing the tyre load to a level at which energy loss within the tyre itself is virtually zero

3.7
machine reading
type of parasitic loss measurement, involving losses of the test machine, exclusive of losses in the rotating spindle bearing, which carries the tyre and rim, and aerodynamic losses

3.8
moment of inertia
ratio of the torque applied to the tyre to the annular acceleration on the tyre

See Annex A.

4 Test methods

The following are alternative measurement methods. The choice of an individual method is left to the tester. For each method, the test measurements shall be converted to a force acting at the tyre/drum interface. The measured parameters are given below.

a) Force method: the reaction force measured at the tyre spindle. This measured value also includes the bearing losses of the tyre spindle and the aerodynamic losses of the tyre and the wheel.

b) Torque method: the torque input measured at the test drum (see NOTE).

c) Power method: the measurement of the power input to the test drum (see NOTE).

d) Deceleration method: the measurement of deceleration of the test drum and tyre assembly (see NOTE).

NOTE This measured value also includes the bearing and aerodynamic losses of the wheel, the tyre and the drum, losses that are also to be considered.

5 Test equipment

5.1 Drum specifications

5.1.1 Diameter

The test dynamometer shall have a cylindrical flywheel (drum)

— with a diameter of at least 1,5 m (reference drum diameter: 1,7 m) for passenger car and motorcycle tyres;

— with a diameter of at least 1,7 m for truck/bus tyres.

It should be noted that the results are different for different diameters; see 9.3 for drum diameter correction for comparisons, if necessary.

NOTE Historically, the measurement of the fore and aft (longitudinal) force on a flat surface machine has been shown to be quite difficult since this force is very small relative to other forces being measured. If a flat surface machine is used, care should be taken to correlate the data with the reference drum diameter in order to assure accurate results.

5.1.2 Surface

The surface of the drum shall be smooth steel or textured and shall be kept clean. For the textured drum surface, see B.4.

5.1.3 Width

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

5.2 Test rim

The tyre shall be mounted on a test rim, as specified in Annex C.

5.3 Load, alignment, control and instrumentation accuracies

Measurement of these parameters shall be sufficiently accurate and precise to provide the required test data. The specific and respective values are shown in Annex C.

5.4 Thermal environment

5.4.1 Reference conditions

The reference ambient temperature, as measured on the rotational axis of the tyre, 1 m away from the plane touching the nearest tyre sidewall, shall be 25 °C.

5.4.2 Alternative conditions

If the reference temperature cannot be obtained, the rolling resistance measurement shall be corrected to standard temperature conditions in accordance with 9.2.

5.4.3 Drum surface temperature

Care should be taken to ensure that the temperature of the test drum surface is approximately the same as the ambient temperature at the beginning of the test.

6 Test conditions

6.1 General

The test consists of a measurement of rolling resistance in which the tyre is inflated and the inflation pressure is allowed to build up (i.e. “capped air”).

6.2 Test speeds

6.2.1 Single test speed

The value shall be obtained at a drum speed as shown in Table 1.

Table 1 — Test speeds

Speed in kilometres per hour

Tyre type	Passenger car	Truck and bus			Motorcycle	
Load index	All	LI 121 and below	LI 122 and above		All	All
Speed symbol	All	All	F to J	K to M	L and below	Above L
Speed	80	80	60	80	50	80

6.2.2 Multiple test speed

Passenger car tyres: the values shall be obtained at drum speeds of 50 km/h, 90 km/h and 120 km/h.

Truck/bus tyres: for LI of 121 and below, the values shall be obtained at drum speeds of 80 km/h and, if required, 120 km/h.

6.3 Test load

The standard test load shall be computed from the values shown in Table 2 and shall be kept within the tolerances specified in Annex C.

Table 2 — Test loads and inflation pressures

Tyre type	Passenger car[a]		Truck and bus	Motorcycle	
	Light and standard load	Reinforced or extra load		Standard load	Reinforced or extra load
Load % of maximum load capacity	80	80	85 (% of single load)	65	80
Inflation pressure kPa	210	250	Corresponding to maximum load capacity for single application	200	250
NOTE The inflation pressure shall be capped with the accuracy specified in C.4.1.					
[a] For those passenger car tyres belonging to categories which are not shown in Annex B of ISO 4000-1:2001, the inflation pressure shall be the inflation pressure recommended by the tyre manufacturer, corresponding to the maximum tyre load capacity, reduced by 30 kPa.					

6.4 Test inflation pressure

The inflation pressure shall be in accordance with those shown in Table 2 and shall be capped with the accuracy specified in C.4.1.

6.5 Duration and speed

When the deceleration method is selected, the following requirements apply:

a) for duration, Δt, the time increments shall not exceed 0,5 s;

b) any variation of the test drum speed shall not exceed 1 km/h.

6.6 Optional conditions

If the sensitivities of load, inflation or speed are desired, the additional information given in Annex B should be consulted.

7 Test procedure

7.1 General

The test procedure steps described below shall be followed in the sequence given.

7.2 Break-in

To ensure repeatability of measurements, an initial break-in and cooling period is required prior to the start of the test. Such a break-in shall be carried out on a test drum of at least 1,5 m diameter (1,7 m for truck and bus tyres) for a period of at least 1 h, at a minimum speed as given in 6.2, per type of tyre, with the load and inflation pressure given in 6.3 and 6.4 respectively.

7.3 Thermal conditioning

Place the inflated tyre in the thermal environment of the test location for the time necessary to achieve thermal equilibrium, which is generally reached after 3 h for passenger car and motorcycle tyres and 6 h for truck and bus tyres.

7.4 Pressure adjustment

After thermal conditioning, the inflation pressure shall be adjusted to the test pressure, and verified 10 min after the adjustment is made.

7.5 Warm-up

The tyre shall be run at constant test speed until reaching a stabilized steady-state value of rolling resistance. Recommendations for warm-up periods are given in Annex B.

7.6 Measurement and recording

The following shall be measured and recorded (see Figure 1):

a) test speed, U_n;

b) load on the tyre normal to the drum surface, L_m;

c) test inflation pressure:

   1) initial, as defined in 7.4

   2) final, for capped inflation;

d) the driving torque on the drive shaft, T_t, the tyre spindle force, F_t, the input power, $V \times A$, or the deceleration of the test drum/tyre/wheel assembly, $\Delta\omega/\Delta t$, depending on the method;

e) distance from the tyre axle to the drum outer surface under steady-state conditions, r_L (see 8.2.1);

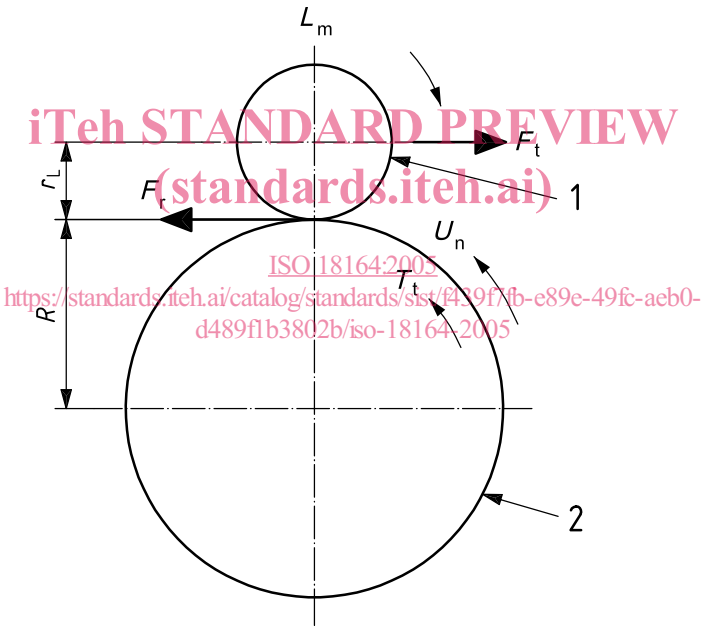
f) ambient temperature, t_{amb};

g) test drum radius, R;

h) rolling resistance force, F_r;

i) test method chosen;

j) test rim (designation and material).



Key

1 tyre
2 drum

Figure 1 — Free-body diagram of tyre/drum system, assuming no bearing and aerodynamic losses

7.7 Measurement of parasitic losses

7.7.1 General

Determine parasitic losses by one of the procedures given in 7.7.2 to 7.7.4.

7.7.2 Skim test reading

a) Reduce the load to maintain the tyre at the test speed without slippage.

b) Record the spindle force, $F_{t,}$ input torque, T_t, or the power, whichever applies.

c) Record the load on the tyre normal to the drum surface, L_m.

NOTE The measured value includes the bearing and aerodynamic losses of the wheel, the tyre and the drum, losses that are also to be considered.

7.7.3 Machine reading

a) Remove the tyre from the drum surface.

b) At the test speed, U_n, record the input torque, T_t, the power, or the test drum deceleration, whichever applies.

NOTE The measured value includes the drum losses to be considered.

7.7.4 Deceleration method

a) Remove the tyre from the test surface.

b) Record the deceleration of the test drum, $\Delta\omega_o/\Delta t$, and that of the unloaded tyre, $\Delta\omega_{po}/\Delta t$.

NOTE The measured value includes the bearing and aerodynamic losses of the wheel, the tyre and the drum, losses that are also to be considered.

8 Data interpretation

8.1 Calculation of parasitic losses

8.1.1 General

The parasitic losses, F_{pl}, related to the tyre/drum interface expressed in newtons, shall be calculated from the force F_t, torque, power or the deceleration, as shown below.

8.1.2 Force method at tyre spindle

Calculate: $F_{pl} = F_t(1 + r_L/R)$

where

F_t is the tyre spindle force in newtons (see 7.7.2);

r_L is the distance from the tyre axis to the drum outer surface under steady state conditions, in metres;

R is the test drum radius, in metres.

8.1.3 Torque method at drum axis

Calculate: $F_{pl} = T_t/R$

where

T_t is the input torque in newton metres as determined in 7.7.2 or 7.7.3;

R is the test drum radius, in metres.