DRAFT AMENDMENT ISO 18164:2005/DAmd 1

ISO/TC **31** Secretariat: **ANSI**

Voting begins on: **2009-03-27** Voting terminates on: **2009-08-27**

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

AMENDMENT 1

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

AMENDEMENT 1

ICS 83.160.10

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Foreword

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Amendment 1 to ISO 18164:2005 was prepared by Technical Committee ISO/TC 31, *Tyres, Rims and Valves*, Subcommittee SC 3, *Passenger Car Tyres and Rims*.

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Annex D

(normative)

Deceleration method based on time-distance measuring.

D.1 Purpose

This Annex specifies the method of rolling resistance determination by measuring time-distance relation during deceleration in chosen speed interval. Rolling resistance as a function of speed including value at 80 (or 60 km/h for the tyres with LI 122 and above and speed symbol J and lower) is the result. Time-distance measuring for the rolling resistance determination excludes the need to measure either deceleration or speed.

D.2 Limitation

This method is alternative to the deceleration method stated in the body of standard for the several constant speed value. Unless otherwise noted all other aspects of the standard apply.

Test conditions limitation stated by ISO 28580 are also satisfied by this method.

D.3 Measurement and recording

D.3.1 Choose warm up procedure in accordance with ISO 18164 section 7.4 or ISO 28580 section 7.3 depending from desired task.

D.3.2 When the warm up is finished, accelerate the test tyre to the speed 90 km/h during not more than 8 s and provide freely coasting motion from the initial speed to the speed 70 km/h (figure D.1). Do it for the loaded test machine with wheel-tyre assembly and then for unloaded test machine with tyre-wheel assembly removed.

NOTE Exclusion: testing speed interval for tyres with LI 122 and above and speed symbol J and lower differs from stated in D.3.2 and limited from 70 km/h to 50 km/h.

D.3.3 During freely coasting motion according D.3.2 record time-distance relations in discrete form:

$$t=f(z)$$

where

t is the time of deceleration from the beginning of first revolution to the end of current revolution;

z is the current number of revolutions of drum or tyre.

D.3.4 Choose from time-distance records in accordance with D.3.3 the values t_1, t_2, t_3, t_4 of deceleration time from the beginning of first revolution to the end of drum revolutions, of the following integer values (figure D.2):

$$z_1,\ z_2=2z_1,\ z_3=3z_1,\ z_4=4z_1$$

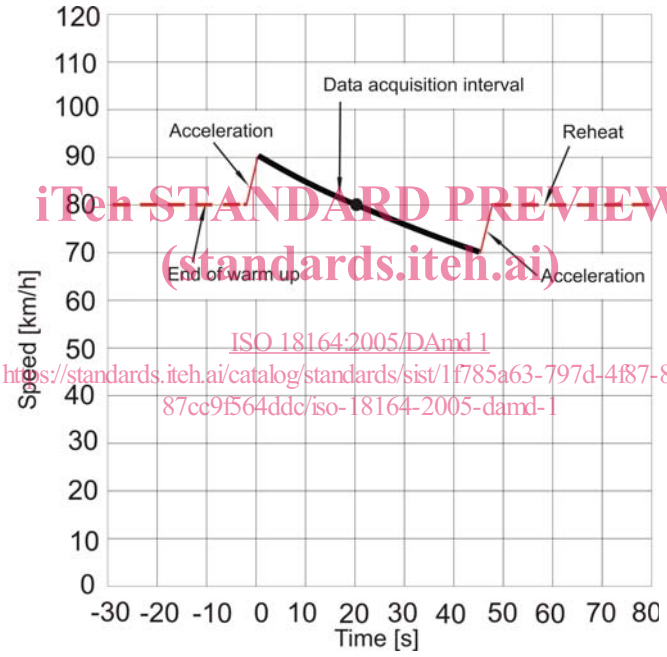

Figure D.1 — Time – speed curve example

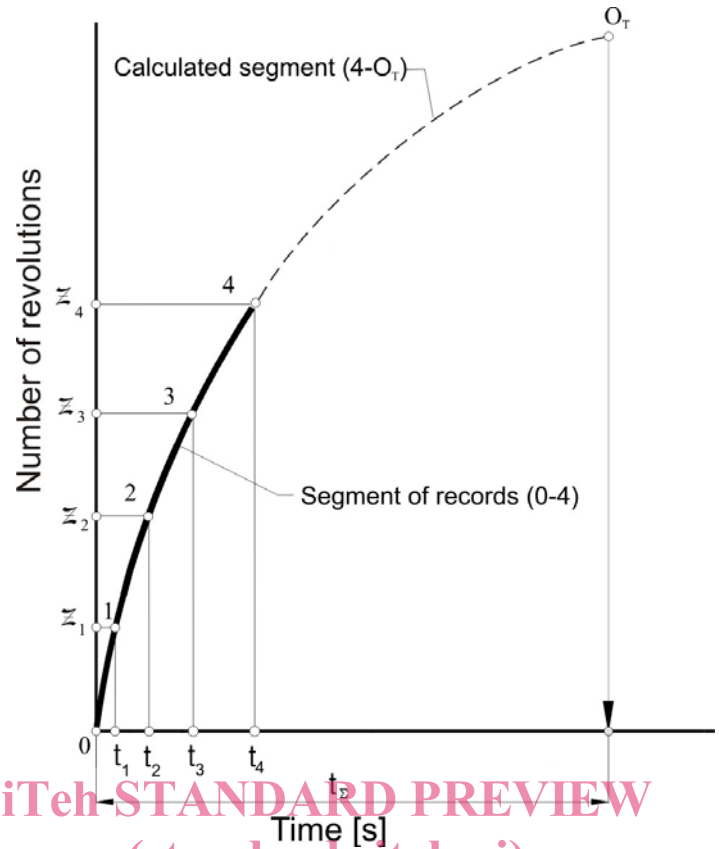

Figure D.2 — Time-distance relation example.

D.4 Data interpretation

D.4.1 Force-speed relation

This data processing method is based on using the regression between tyre rolling resistance (as well as parasitic losses) and speed *U* as:

$$F = P + QU^2$$

where:

F is the resistance or losses, in Newtons;

P is the initial value of *F* (at zero speed), in Newtons;

Q is the coefficient of speed influence on *F* , in kilograms per meter;

U is the circumferential velocity of rotating body, in meters per second.

D.4.2 Equation of deceleration motion

Application of laws of mechanics to the drum/tyre/wheel assembly or its parts leads to the following equation:

$$-\frac{I}{r^2}\frac{dU}{dt} = F$$

where:

I is the inertia of rotating mass, in kilograms meter squared;

r is the radius of the rotating body, in meters.

F is as defined in D.4.1

D.4.3 Time – distance regression

A solution of the equation, presented in D.4.2 is

$$z = z_\Sigma - \frac{I}{2\pi r^3 Q} ln\cos B(t_\Sigma - t)$$

where:

z_Σ is the number of revolutions during total deceleration time;

t_Σ is the total deceleration time (the time from the beginning of first revolution to the zero speed);

B is the parameter, in unity per second, related to P and Q and determined by:

$$B = \frac{r}{I}\sqrt{2PQ}$$

NOTE: number of revolutions z_s includes the last one which may be half-unit.

D.4.4 Parameters of time – distance regression

A solution of the equation, presented in D.4.3 and applied to the records in accordance with D.3.4 yields the relations

$$P = \frac{2p z_4 I B^2 \cos Bt_s}{r\cos B(t_s - t_4)}$$

$$Q = \frac{I^2 B^2}{r^4 P}$$

in which parameters B and t_Σ are determined as roots of the equation system

$$\begin{cases} \cos^2 B(t_\Sigma - t_1) = \cos Bt_\Sigma \cos B(t_\Sigma - t_2) \\ \cos^2 B(t_\Sigma - t_3) = \cos B(t_\Sigma - t_2)\cos B(t_\Sigma - t_4) \end{cases}$$

D.4.5 Total resistance and parasitic losses parameters calculation

Calculate the three pairs of parameters P and Q using formulas and equation system in D.4.4

P_Σ and Q_Σ for loaded tyre/wheel/drum system;

P_D and Q_D for unloaded test machine;

P_T and Q_T for removed tyre/wheel/hub assembly

substituting corresponded I values of test system inertia moments:

I_D - the test drum inertia in rotation for calculations P_D and Q_D, in kilogram meters squared;

I_T - the tyre/wheel/hub assembly inertia in rotation for calculations P_T and Q_T, in kilogram meters squared;

I - the tyre/wheel/drum system inertia in rotation for calculations P_Σ and Q_Σ, in kilogram meters squared:

$$I = I_D + I_T \left(\frac{R}{R_T}\right)^2$$

where:

R is the drum radius, in meters;

R_T is the tyre rolling radius, in meters.

NOTE: Recommendations for the measurements of the moments of inertia are given in D.5.

D.4.6 Rolling resistance calculation

D.4.6.1 Calculate the tyre rolling resistance F_r using the values obtained according to D.4.1 by subtracting into the formula:

$$F_r = P_S - P_D - P_T + (Q_S - Q_D - Q_T)U^2$$

where the parameters notation is given in D.4.5.

NOTE It is recommended to use this formula for the extrapolation up to the speed value of 30% higher than initial test speed shown in D.3.2.

D.4.6.2 Calculate the tyre rolling resistance at 80 km/h (F_{r80}) using the formulae in D.4.6.1 substituting the value U=22,2 m/s or F_{r60} for the tyres with LI 122 and above and speed symbol J and lower substituting U=16,67 m/s.