Transmitted by the expert
from the Russian Federation

Informal Document **GRB-56-02**
(56th GRB, 3-5 September 2012,
agenda Item 6)

Proposal for Supplement 3 to the 02 series of amendments to Regulation No. 117 (Tyre rolling noise, wet grip adhesion and rolling resistance)

At the 155th WP.29 session the GRB Chair regarding measuring tyre rolling resistance in the Regulation No. 117 clarified that GRB adopted a Supplement to the Regulation that will not affect the existing test methods but will rather constitute an alternative to improve the accuracy of the deceleration method (ECE/TRANS/WP.29/1093, para. 41).

At the 55th GRB session in February 2012, referring to the report of the September 2011 session of GRB the Chair of GRB clarified that the document GRB-54-12-Rev.1 adopted at its September 2011 session, will not affect the existing test methods but will rather constitute an alternative to improve the accuracy of the deceleration method. The expert from ETRTO confirmed the clarification of the Chair. The expert from France supporting the adoption by WP.29 of GRB-54-12-Rev.1, expressed the need of detailed elaboration of the concept of tyre deceleration (dω/dt) in the test technology (see ECE/TRANS/WP.29/GRB/53, para. 15),

The text reproduced below was prepared by the experts from the Russian Federation as a response on the above mentioned expectation.

I. Proposal

Annex 6

Paragraph 3.5., amend to read:

"3.5. Duration and speed.

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

(a) The deceleration j shall be determined in exact dω/dt or approximate Δω/Δt form, where ω is angular velocity, t – time;

If the exact form dω/dt is used, then the recommendations of Appendix 4 to this Annex to be applied.

(b) …"

Annex 6, insert a new Appendix 5, to read:

"Annex 6 – Appendix 5

Deceleration method: Measurements and data processing for deceleration value obtaining in differential form dω/dt.

1. Record dependency "distance-time" for rotating body in a discrete form:

$$\alpha_i = i\Delta\alpha = \varphi(t_i)$$

where:

α_i is an angle of body rotation during deceleration from speed 80 to 60 km/h or 60 to 40 km/h dependently of PC or CV tyre in radians.

i is the number of constant angle increments;

$\Delta\alpha$ is constant increment of angle of rotation in radians;

t_i is time in seconds.

Note: The recommended value of $\Delta\alpha$ is 2π for testing PC tyres and π for CV tyres.

2. Insert measured data into the "deceleration calculator" downloaded from http://www.unece.org/fileadmin/DAM/trans/doc/2012/wp29grb/calculator.zip and obtain:

2.1. Constants of approximating dependency:

$$\alpha = f(t) = A \ln \frac{1}{\cos B(T_\Sigma - t)},$$

where:

A is constant in radians,

B is constant in 1/s;

T_Σ is constant in s.

2.2. The result in accordance of relations for speed 80 (60) kph:

$$j = \frac{d\omega}{dt} = \frac{d^2\alpha}{dt^2} = \frac{AB^2}{\cos^2 BT_\Sigma}$$

2.3. The estimation of approximation executed by quadrature R^2 and by standard deviation σ which is also an estimation of parameter j accuracy."

II. Justification

The proposed principal is based on an absolutely exact perform:

$$j = \frac{d\omega}{dt} = \frac{d^2\alpha}{dt^2}$$

Really, there are no any suppositions, simplification or assumption between formulae in clauses 2.1 and 2.2 of Appendix 7 because formula in clause 2.2 is derived from formula in clause 2.1 according to the rules of differential calculus:

$$j = \frac{d^2\alpha}{dt^2} = \frac{AB^2}{\cos^2 B(T_\Sigma - t)}$$

As soon as the measurements begin at 80 (60) km/h when t = 0, one can obtain formula shown in clause 2.2 of Appendix 7. This means that an accuracy of the result j depends from a quality of approximation of empirical dependency α=f(t) by formulae in clause 2.2.

The "deceleration calculator" presents for user's acceptance the estimation of the result in the form of a standard deviation σ:

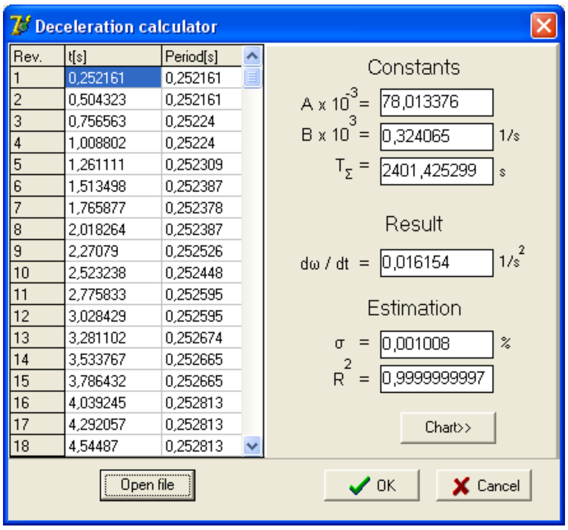
$$\sigma = \sqrt{\frac{1}{n-1}\sum_{i=1}^{n}[\alpha_i - f(t_i)]^2}$$

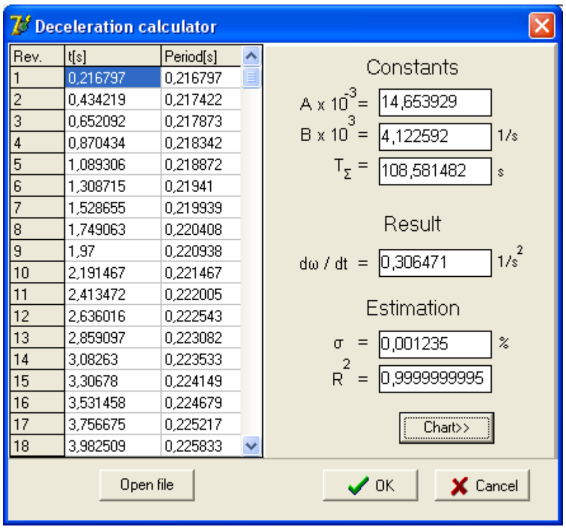
where $f(t_i)$ is approximating dependency from clause 2.1 of Appendix 7 in a discrete form, and in a form of quadrature R^2 of coefficient of correlation for non-linear approximation:

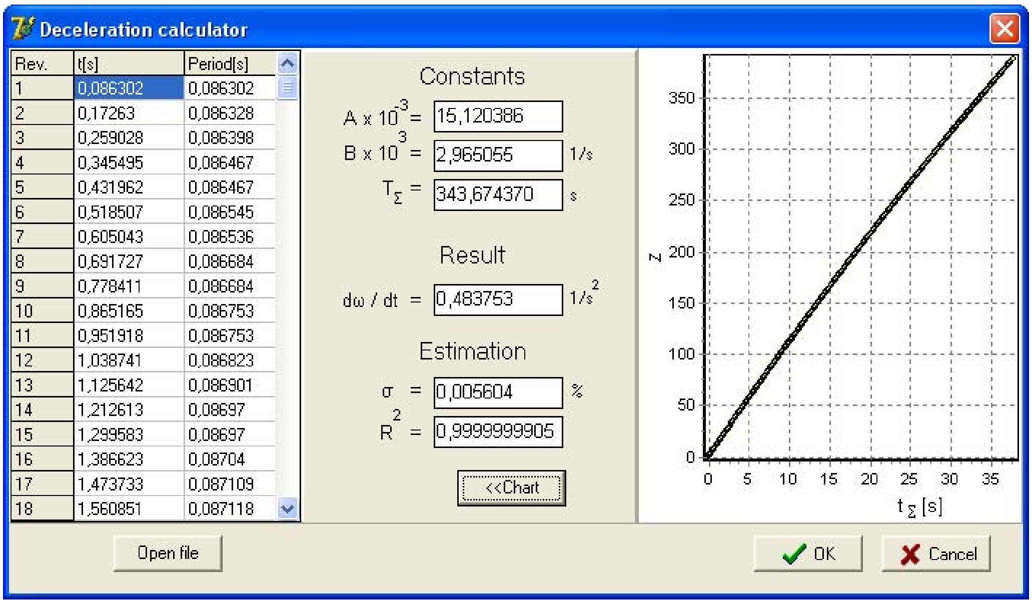
$$R = \sqrt{1 - \frac{\sum_{i=1}^{n}[\alpha_i - f(t_i)]^2}{\sum_{i=1}^{n}(\alpha_i - \overline{\alpha})^2}}$$

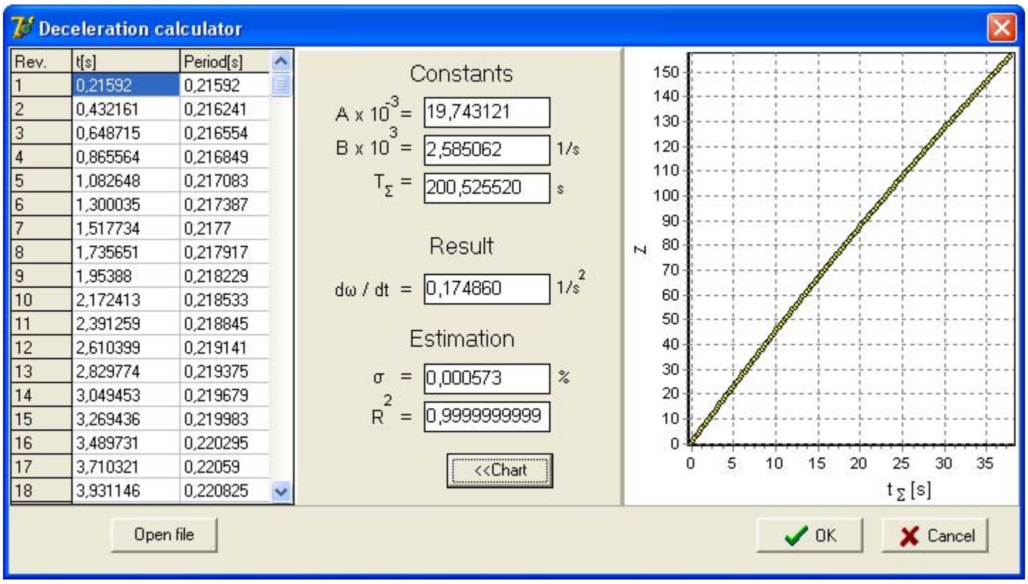
where $\overline{\alpha} = \frac{1}{n}\sum \alpha_i$

A user may also push the button "chart" and have the graph with lens $\alpha = f(t)$ among empirical points. The examples given hereinafter show described opportunities and an exclusively high quality of approximation:








Deceleration calculator
Rev. t[s] Period[s]
1 0,21592 0,21592
2 0,432161 0,216241
3 0,648715 0,216554
4 0,865564 0,216849
5 1,082648 0,217083
6 1,300035 0,217387
7 1,517734 0,2177
8 1,735651 0,217917
9 1,95388 0,218229
10 2,172413 0,218533
11 2,391259 0,218845
12 2,610399 0,219141
13 2,829774 0,219375
14 3,049453 0,219679
15 3,269436 0,219983
16 3,489731 0,220295
17 3,710321 0,22059
18 3,931146 0,220825
Constants
A x 10^-3 = 19,743121
B x 10^3 = 2,585062 1/s
T_Σ = 200,525520 s
Result
dω / dt = 0,174860 1/s^2
Estimation
σ = 0,000573 %
R^2 = 0,9999999999
<<Chart
Z
t_Σ [s]
Open file
OK
Cancel