Proposal for Supplement 5 to the 02 series of amendments to Regulation No. 117

Submitted by the expert from the Russian Federation

The text reproduced below was prepared by the experts from the Russian Federation to elaborate on the concept of tyre deceleration (dω/dt) in the test technology. It is based on ECE/TRANS/WP.29/GRB/2013/3, incorporating amendments as proposed in a document without symbol (GRB-57-01) distributed at the fifty-seventh session of the Working Party on Noise (GRB)/(ECE/TRANS/WP.29/GRB/55, para. 18). The modifications to the existing text of the UN Regulation are marked in bold for new or strikethrough for deleted characters.

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1 In accordance with the programme of work of the Inland Transport Committee for 2010–2014 (ECE/TRANS/208, para. 106 and ECE/TRANS/2010/8, programme activity 02.4), the World Forum will develop, harmonize and update Regulations in order to enhance the performance of vehicles. The present document is submitted in conformity with that mandate.
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 \( \frac{d\omega}{dt} \) or approximate \( \frac{\Delta \omega}{\Delta t} \) form, where \( \omega \) is angular velocity, \( t \) – time;

If the exact form \( \frac{d\omega}{dt} \) is used, then the recommendations of Appendix 4 to this Annex are to be applied.

(b) …"

Annex 6, insert a new Appendix 4, to read:

"Annex 6 – Appendix 4

Deceleration method: Measurements and data processing for deceleration value obtaining in differential form \( \frac{d\omega}{dt} \).

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

\[
\alpha_i = i \Delta \alpha = \varphi(t_i)
\]

where:

\( \alpha_i \) is an angle of body rotation during deceleration from speed 80 to 60 km/h or 60 to 40 km/h dependent of the 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 \( 2\pi \).

2. Insert measured data into the "deceleration calculator" downloadable from www.nami.ru/upload/calculator.zip and obtain:

2.1. Constants of approximating dependency:

\[
\alpha = f(t) = A \ln \frac{1}{\cos B(T_s - t)} ,
\]

where:

\( A \) is constant in radians;

\( B \) is constant in 1/s;
Σ is constant in s.

2.2. The result is in accordance with the use of a speed of 80 (60) kph:

\[ j = \frac{d\omega}{dt} = \frac{d^2\alpha}{dt^2} = \frac{AB^2}{\cos^2 BT} \]

II. Justification

1. The proposed principal is based on an absolutely exact formula:

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

2. There are no real simplification or assumption between the formulae in clauses 2.1 and 2.2 of Appendix 4 because the formula in clause 2.2 is derived from the formula in clause 2.1 according to the rules of differential calculus:

\[ j = \frac{d^2\alpha}{dt^2} = \frac{AB^2}{\cos^2 B(T - t)} \]

3. As soon as the measurements begin at 80 (60) km/h when \( t = 0 \), one can obtain the formula shown in clause 2.2 of Appendix 4. This means that the accuracy of the result \( j \) depends on a quality of approximation of empirical dependency \( \alpha = f(t) \) by formulae in clause 2.1.

4. The “deceleration calculator” presents the estimation of the result in the form of a standard deviation \( \sigma \):

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

where \( f(t_i) \) is approximating dependency from clause 2.1 of Appendix 4 in a discrete form, and in a form of quadrature \( R^2 \) of coefficient of correlation for non-linear approximation:

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

where \( \bar{\alpha} = \frac{1}{n} \sum \alpha_i \)

5. The measurement method together with the “Deceleration Calculator” provide for the approximation accuracy typically reached by quadrature \( R^2 > 0.9999 \) and by standard deviation \( \sigma < 0.03\% \).

6. A user may also check on the button “chart” and have the graph with lens \( \alpha = f(t) \) among empirical points. The examples given here after show opportunities and an exclusively high quality of approximation: