

Comments of the Expert from Poland on the
“Proposal for draft amendments to Regulation No 79”
(TRANS/WP.29/GRRF/2002/24)

1. Dimensions of the road surface required for the measurement of the effort put on the steering wheel according to proposed amendment of p.6.2.2.

In order to obtain the full characteristic of the steering system in the condition of a constant speed of driving $V=10\text{km/h}$ and rotary speed of the steering wheel $d\delta_H/dt=20^\circ/\text{s}$ or $50^\circ/\text{s}$ in the left and right directions the vehicle shall be appropriately positioned at the start of turning of the steering wheel.

Fig. 1. illustrates the trajectory of the movement of the center of gravity of the truck obtained from the computer analysis of its modelled run.

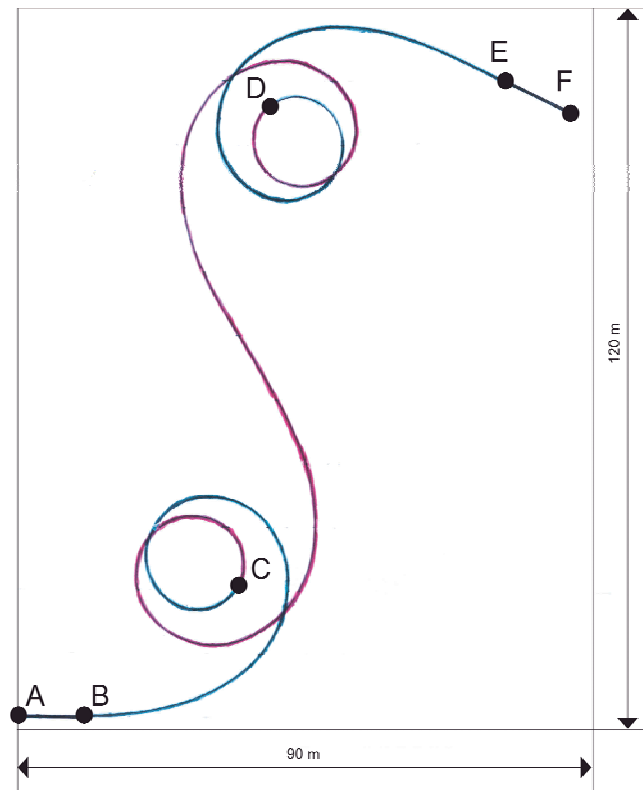


Fig. 1

In the point A the vehicle already runs on the straight line with a constant speed $V = 10\text{km/h}$. After driving the distance of about 10m to the point B the turn of steering wheel starts in left with a constant speed $d\delta_H/dt = 20^\circ/\text{s}$ and from this moment the turn angle δ_H and the effort F put on the steering wheel are being recorded.

The full turn of the steering wheel is completed in the point C in which the direction of turn is being reversed (in right) till the full turn in the point D and then the direction is changed (in left) till reaching the center position in the point E. At this position the measurements are finished but the straight line driving is continued on the distance of 10m to the point F. Such cycle of the test needs the area of at least $90 \times 120\text{m}$.

Fig.2 presents the trajectory of the similar measurement but for the turn of steering wheel with a constant speed $d\delta_H/dt = 50^\circ/\text{s}$.

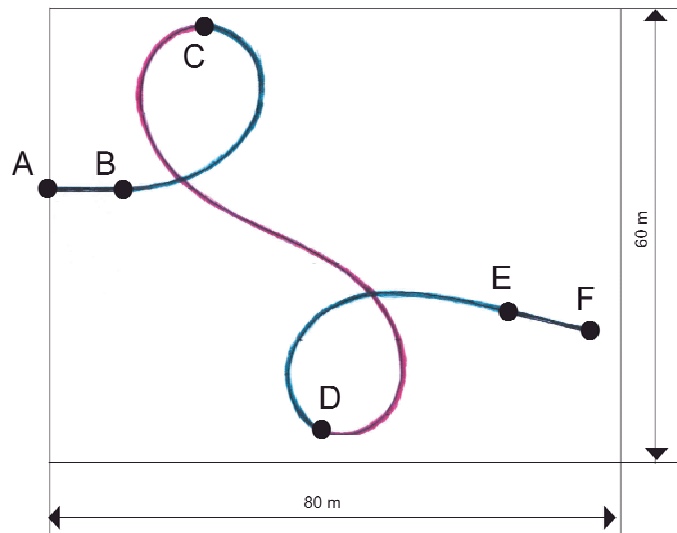


Fig. 2

In this case the straight line of vehicle starts also in the point A. In the point B the measurement starts and is made in the same manner as described above till the end of the vehicle run. For above mentioned way of the test area of $80 \times 60\text{m}$ would be enough. A comparison of both trajectories indicates that the higher speed of the steering wheel turning allows to make the measurements on the smaller area.

It is important to start the measurements in the defined point B. The point of the measurement's end depends on the method used for the tests and the design of vehicle.

Fig. 3 presents the trajectory of the vehicle obtained during manoeuvres and measurements according to the proposed test with a constant speed of $d\delta_H/dt = 20^\circ/s$.

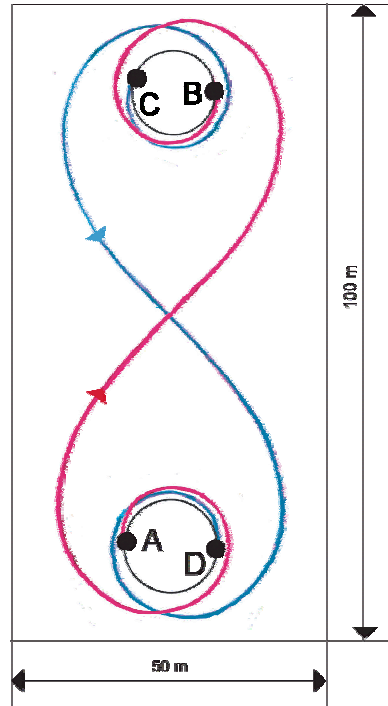


Fig. 3

The measurement starts with a constant speed of vehicle $V = 10\text{km/h}$ at the full turn of steering wheel (when vehicle runs on the circle).

In the defined point A the steering wheel rotation starts and reaches the full turn in the point B.

In this position the steering wheel is maintained for a moment and then, a little later, in the point C, it changes the movement in opposite direction till the full turn in the point D. The measurement of the full characteristics could be finished in this point. Such way of test requires only the area of $50 \times 100\text{m}$.

If the measurement is made with a speed of steering wheel of about $d\delta_H/dt = 50^\circ/s$ this area reduces to $30 \times 60\text{m}$.

In our tests the measurements were performed on the runway of the airport with the path width of about 80 to 100m.

Such conditions, even for the large vehicles with the wheel base of about 6100mm and the gear ratio of the steering system $i > 25$ did not produce the significant difficulties.

However it must be underlined that before the measurement it is necessary to choose in an experimental way the actual points of the vehicle positions in which turning of steering wheel shall be:

- started (point A)
- stooped after completing the full turn (point B)
- repeated in the opposite direction (point C)
- stooped at the end of measurements (point D)

2. The steering time required during driving the vehicle into required bend of a road for the measurement of steering effort according to p.p. 6.2.5.2 and 6.2.6.2.

Max permissible steering time according to Regulation No 79 equals to 4s (or 6s with the failure of the steering control of vehicles M_3 and N_3).

This requirement assumes that during the tests it is also possible to obtain the proper value of the effort in the shorter time than given above.

In PIMOT the measurements of this effort were done on two different vehicles of cat. M_1 (without the power assistance of the steering system) in conditions defined in Regulation No 79 but at the various values of the steering time ranging from 0,5s to 18,0s.

Fig. 4 presents the values of effort F_{12} (and torque M_{12}) in relation to the steering time t_{12} when the vehicle attained the required external turning radius R_{12} in both directions.

The points marked by x and o are related to the steering system of the first vehicle and points \square and \triangle to the second one.

The diagram in Fig.4 indicates that shorter time than 4s requires greater effort on the steering wheel.

If t_{12} exceeds 4s than the effort F_{12} at the time of left turning was greater than in right direction but their relations to the steering time t_{12} were similar.

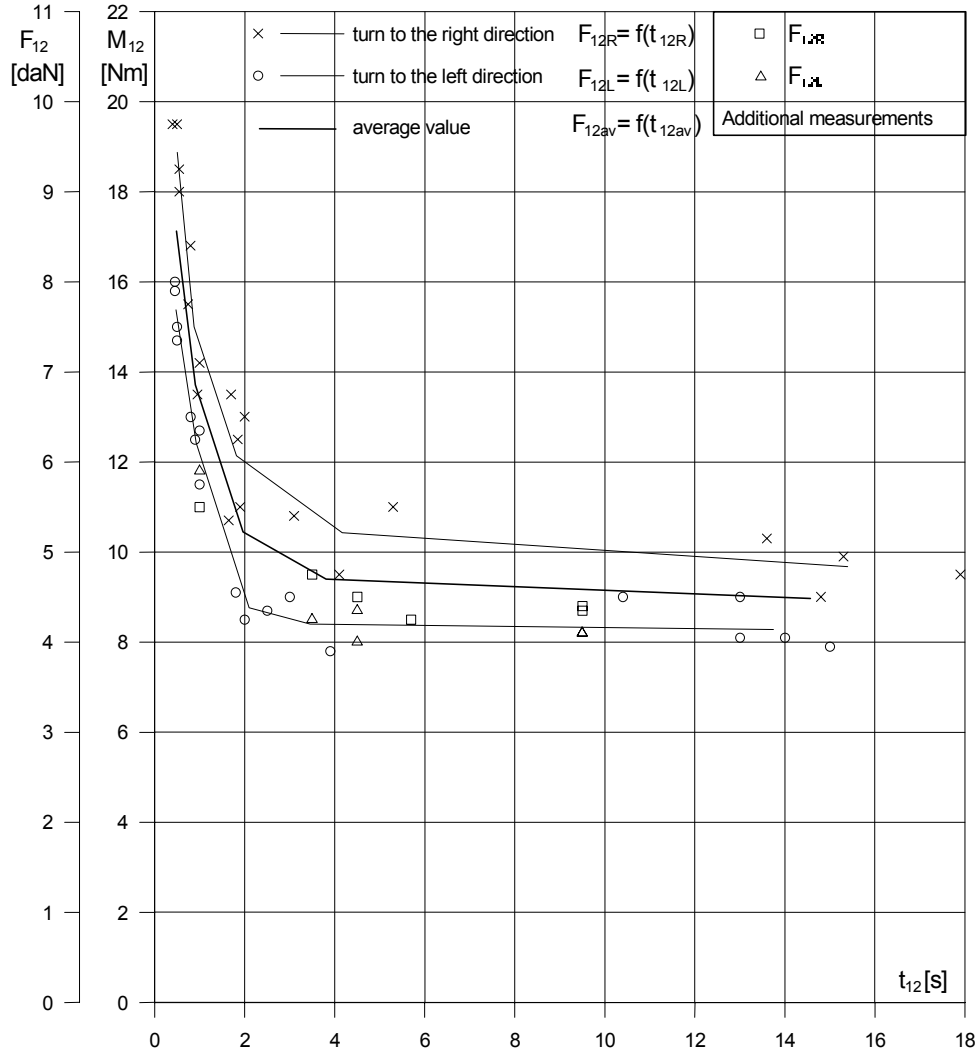


Fig. The force F_{12} at the steering wheel (or torque M_{12}) used to put the vehicle into the curve of road with the outside contour diameter $R = 12$ m at the speed $V = 10$ km/h in the function of time t_{12}

Fig. 4

In the second one such great difference is not evident and the characteristics $F_{12} = f(t_{12})$ are almost identical for both directions.

According to p.6.2.5.1 of Regulation No 79 the vehicle driven with the speed 10km/h shall be driven from straight to spiral line. During the measurement most important is to keep the constant speed of steering wheel ($d\delta_H/dt = \text{constant}$).

This parameter influences in significant way the repeatability of measured results.

On the bases of the large number of vehicles tested in PIMOT we can conclude that the angle $d\delta_{H12}$ of steering wheel at which was measured the effort for vehicles categorie M_1 without the power assistance of the steering system was comprised in limits 200° to 360° .

The rotation of the steering wheel in such range of angles during 4 seconds requires the speed in range from $52,5^\circ/\text{s}$ to $90^\circ/\text{s}$.

This range fulfils also the requirements for vehicles categorie M_1 equipped with the power assistance of the steering system.

The largest vehicle of categorie M_3 tested in PIMOT with the wheel base $L = 6100\text{mm}$ and the ratio of the steering system $i = 25,5$ required the turning of the steering wheel for the angle $d\delta_{H12} = 900^\circ$ in order to drive it in to the bend with the external radius $R = 12\text{m}$. This manoeuvre demanded the turning of the steering wheel with a speed $d\delta_{H12}/dt = 225^\circ/\text{s}$ in the time of 4 seconds which is relatively difficult.

In practice most contemporary vehicles categories M_3 and N_3 are equipped in the power assisted steering systems and thus the effort on the steering wheel is in the most cases very small in comparison to the present required values.

For the groups of vehicles categories M_3 and N_3 the basic one is the measurement of the steering effort when the power assistance failed and usually it is difficult to obtain the required values.

In the case of mentioned vehicle M_3 when the power assistance failed the measured effort on the steering wheel in conditions of Regulation No 79 required the turn of the steering wheel for the angle $\delta_{H20} = 540^\circ$ and in order to receive above value in the time 6 seconds the driver must rotate the steering wheel with the speed $d\delta_{H20}/dt = 90^\circ/\text{s}$. Our experience indicates that as the measurement is performed with the constant speed of vehicle $V = 10\text{km/h}$ even the significant lowering of the rotary speed of steering wheel does not evidently influence the steering effort value.

It is only important to maintain during the measurements the constant speed of steering wheel (without jerks).

In conclusion it is proposed to replace in the measurement procedure of the steering effort “the steering time” by “the maintenance of constant rotary speed of steering wheel “ in the range from $20^{\circ}/s$ to $50^{\circ}/s$.
