



## SPEED CHANGES ON THE SECTION OF A ROAD AND THEIR IMPACT ON THE GEARBOX OPERATION

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### Abstract

The network of roads on the territory of a specific area is subject to different divisions. There are speeds assigned to sections occurring at different areas. Justification for the level of their assignment is different, and very often is unconnected from the conditions which are to be observed in correct exploitation of vehicles. So, the divergences in exploitational arrangements for a road and vehicles are contradictory. The consequences of these divergences emerge in speeding up of the wear and tear of many vehicle's assemblies, including a gearbox.

**Key words:** speeds on roads, limitation in the vehicles' traffic, wear and tear of a gearbox.

### INTRODUCTION

The networks of roads allowing the movement of vehicles, constitute the element of the state's assets managed by its administrative units, both the centralized ones as well as the regional ones. This management covers, among the others, ensuring of the required exploitational conditions including determination of possible speeds for individual roads. Undoubtedly, the following elements constitute the grounds for making arrangements within that scope:

- state of the road,
- its location,
- surroundings of the road,
- construction of the road/ width, profile /.

The issue of speed on the roads in Poland is covered by the regulation of the Minister of Transport and Maritime Economy of March 3, 1999 on the technical conditions that public roads and their use should correspond to. In that regulation, it has been specified in particular the design speed, as the technical and economical parameters that the boundary value of the road elements, proportions among them and the scope of a road's fittings are assigned to (*Regulation, 1999*). So, the design speeds established for individual road classes are presented in the table 1 (*Regulation, 1999*).

**Tab. 1** Designed speeds for individual classes of roads in Poland

Class of road		A	S	GP	G	Z	L	D
The design speed of road (km/h)	Outside city limits	120	120	100	70	60		
		100	100	80	60	50	50	40
		80	80	70	50	40	40	30
	Inside city limits	80	70	60	60	60	40	
		70	60	50	50	50	30	30
		60				40		

A road, due to most often common accessibility, adopts the character of an universal infrastructure. So, the arrangements for these roads do not take into consideration the diversity of vehicles travelling on them, and in particular, of their performance parameters specified by producers/ designers/ and the terms of their use. The situation in transport takes notes of adjustment of the means of transport to the characteristics of a road in principle in one case, that is, with reference to ships/ vessels/ inland shipping, where adjustment of the means of transport to the waterway's parameters takes place. The occurring discrepancies between the road infrastructure /motor transport / and the conditions of correct exploitation of the means of transport – vehicles, have a negative impact on the process of their use. The objective situation was verified on the basis of the selected section of the road and a vehicle. However, the purpose of this article is, in particular, presentation of the obtained results and through them – pre-



sending of paradoxical and inconsistent operational solutions anticipated and realized for roads and vehicles. The made findings point at absurdity in roads administrators proceeding with reference to the implemented speed limits.

## MATERIALS AND METHODS

The route of the national road no 80, connects among the others the cities Bydgoszcz – Toruń and remains in its part in the network of municipal streets of both the cities. The course of the road comprises the places: Pawłówek – Bydgoszcz – Fordon – Toruń – Lubicz Dolny and amounts to 66,0 km. For the findings, within the frames of the conducted studies, there was taken into consideration the section connecting both the cities between the central points determined to be the head offices of the Polish Post. So, the subject study was started by the head office of Polish Post at Jagiellońska 6 st. in Bydgoszcz. For the studies – findings, there was used the vehicle make Skoda model Octavia version Elegance. The vehicle is characterised by the following data:

- year of production – 2010,
- cylinder capacity 1798 cm<sup>3</sup>
- power 160 KM/118 kW
- odometer reading 27553 km
- volume of fuel in the tank – full.

Selection of the vehicle for the studies results from the fact, that both the brand names as well as the model, dominate among the vehicles exploited on Polish roads.

That vehicle had a valid periodical vehicle technical inspection conducted at the Motor Vehicle Diagnostic Station /PSKP/, lately conducted on May 17, 2017 / according to the provisions in force valid for the period of one year /. That vehicle has also undergone the inspection and servicing activities that should be performed every two years were conducted by the authorised service station on June 28, 2016. Pressure in the vehicle's wheels was controlled on the day preceding the inspection, and according to the producer's recommendations it was written down on the filler's cover.

The test was conducted on May 26, 2017. It was a sunny day, no precipitations, dry surface. At the moment of the test's commencement, that is at 6.07 the temperature was 12 °C and was determined on the basis of the indications of the sensor presented at the display. In order to determine the total distance as well as the distance of individual sections of the road, there was used the correctly functioning daily vehicle's odometer.

The test was started at 6.07 by the head office of Polish Post at Jagiellońska 6 st. in Bydgoszcz. The time for the findings was to allow for easy vehicle's drive in the conditions of average traffic.

Carrying out of the findings was completed at 7.03 by the head office of Polish Post in Toruń at Piekary 26 st. Along the whole route there were no disruptions and the weather conditions remained unchanged. The outside temperature at the moment of the tests' completion amounted to 13,5 °C. The odometer reading confirmed travelling the distance of 46,8 km. Because of the traffic limitation on the Staromiejski market, the test was completed at Piekary street. The passage was realized as the drive in easy traffic in accordance with the road safety procedures and occurring limitations. The course of the tests at the time of passage, that also means that the made findings were documented on a current basis in the prepared reports. At the time of the tests certain inconsistencies in determining speed for the subject section of the road by that road's administrator were found. However, it had no impact on the made findings.

## RESULTS AND DISCUSSION

At the time of the values' testing – parts of the section together with speeds assigned to them, describing thereby the changes in the vehicle's driving are presented in the table 2. In the table below, the division of the whole road's section into the municipal and rural areas is presented.

**Tab. 2** List of the results of the test divided by areas

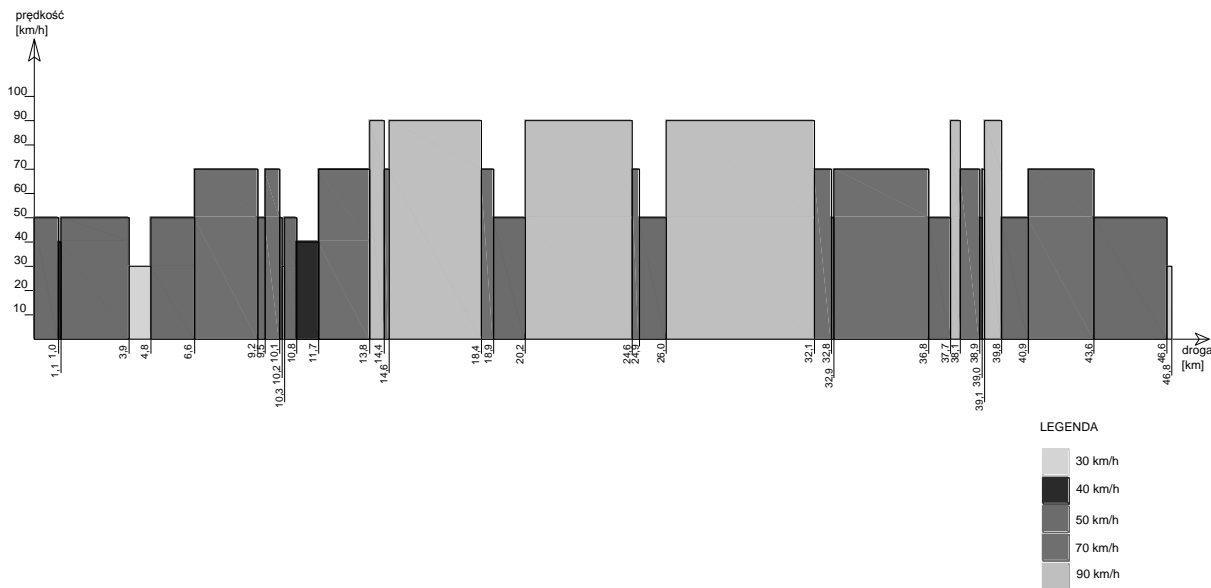
No.	Areas covered by findings	Kilometer of road from – to	Speed limit (km/h)	Distance of limitation (m)
1	2	3	4	5
1		0,0 – 1,0	50	1000



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2		1,0 – 1,1	40	100
3		1,1 – 3,9	50	2800
4		3,9 – 4,8	30	900
5		4,8 – 6,6	50	1800
6		6,6 – 9,2	70	2600
7		9,2 – 9,5	50	300
8		9,5 – 10,1	70	600
9		10,1 – 10,2	50	100
10		10,2 – 10,3	30	100
11		10,3 – 10,8	50	500
12		10,8 – 11,7	40	900
	Total municipal in Bydgoszcz			11700
13		11,7 – 13,8	70	2100
14		13,8 – 14,4	90	600
15		14,4 – 14,6	70	200
16		14,6 – 18,4	90	3800
17		18,4 – 18,9	70	500
18		18,9 – 20,2	50	1300
19		20,2 – 24,6	90	4400
20		24,6 – 24,9	70	300
21		24,9 – 26,0	50	1100
22		26,0 – 32,1	90	6100
23		32,1 – 32,8	70	700
24		32,8 – 32,9	50	100
25		32,9 – 36,8	70	3900
26		36,8 – 37,7	50	900
27		37,7 – 38,1	90	400
28		38,1 – 38,9	70	800
29		38,9 – 39,0	50	100
30		39,0 – 39,1	70	100
31		39,1 – 39,8	90	700
	Total rural			28100
32		39,8 – 40,9	50	1100
33		40,9 – 43,6	70	2700
34		43,6 – 46,6	50	3000
35		46,6 – 46,8	30	200
	Total municipal in Torun			7000
36	Total	46,8	x	46800

The layout of the occurring speeds falling on individual sections occurring in the measurement order is presented on the graph 1. In particular also the presentation of “jumps” in speeds has also been taken into consideration in it. The average speed of the vehicle classified to be technical and reached at the time of the test amounted to below 50 km/h.



**Fig. 1** Speeds falling on individual sections of a road

It results from the above graph, to what extent the gearbox is used for performance of brakings and speedings. Easy driving also does not occur outside the built-up area, on the section of which there are speed limits covering only 100 running meters of the road.

From the presented by the producer graphical information, in the factory's manual concerning economical change of gears it results, that their transmission should cover the ranges: (Manual 2010)

- on gear II from 15 to 50 km/h
- on gear III from 30 to 62 km/h
- on gear IV from 45 to 80 km/h
- on gear V from 50 to 102 km/h
- on gear IV from 58 to 110 km/h.

The maximum speed has been determined to amount to 223 km/h (Schwarz, 2010).

Higher gear should be switched on at the engine speed of about 2000 to 2500 revolutions per minute. "Early" switching on a higher gear is an effective manner of fuel's saving. Reaching the top of the engine speed's range on gear results in unnecessary fuel consumption. The highest consumption of fuel is on the first gear, the lowest one on the fifth or the sixth gear. The farsighted and economical mode of driving makes it possible to reduce easily the fuel consumption for 10 – 15 %. (Manual 2010) Optimizing the manufacturer's instructions included in the manual and concerning the use of the gearbox's transmissions, increase of the output speed for each of them was made by half of the areas of the ranges determined for them. Taking the above into account it may be assumed, that the gears should have been changed having reached the speeds and respectively:

- from II to III at 32,5 km/h,
- from III to IV at 46.0 km/h,
- from IV to V at 62,5 km/h,
- from V to VI at 84,0 km/h.

Gearbox transmissions, according to the Extract from the homologation certificate are the following: (Extract from the homologation, 2010)

- I gear – 3,778
- II gear – 2,063
- III gear – 1,455
- IV gear – 1,107
- V gear – 0,875
- VI gear – 0,725.

It results from the above, that the speeds determined with limits may be reached respectively:

- 30 km/h – on the second gear,
- 40 km/h – on the third gear,
- 50 km/h – on the fourth gear,
- 70 km/h – on the fifth gear,
- 90 km/h – on the sixth gear.

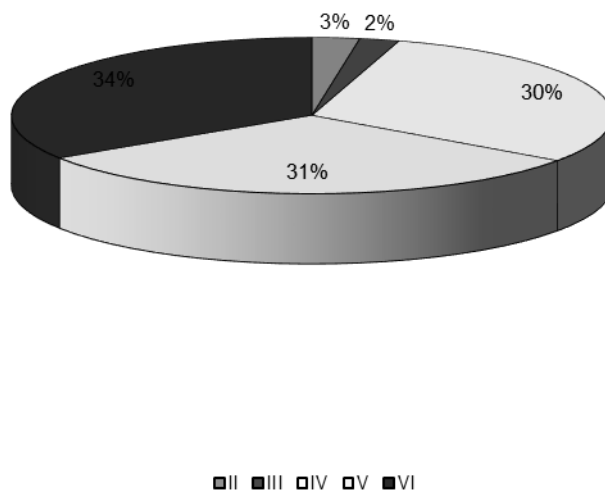


The scale of the gearbox transmissions and its use on the tested section is presented in the table 3.

**Tab. 3** The ranges of use of gearbox transmissions on the covered section of the road

Lp.	Speed in occurring limits km/h	Used gear	Road travelled in the speed limit in km	Structure of use of the gearbox transmissions in %
1	2	3	4	5
1	30	II	1,2	2,56
2	40	III	1,0	2,14
3	50	IV	14,1	30,13
4	70	V	14,5	30,98
5	90	VI	16,0	34,19
6	x	x	46,8	100,00

It results from the above, that only on the section covering in total 16,0 km the speed anticipated for the national road, that is 90 km/h was used. The degree of use of the gearbox transmissions is graphically presented on the graph 2.



**Fig. 2** The degree of use of the gearbox transmissions on the tested section

The part of the section of the road visible on the graph, travelled with the speed of 50 km/h should be considered incorrect from the point of correct passenger vehicle's exploitation, and this on account of the fact that the average at present for them possibility of travelling amounts to approx. 200 km/h.

## CONCLUSIONS

The vehicle used for the tests has a manual gearbox having six transmissions/ six gears. The first of them, pursuant to the instructions of the producer included in the manual, is to be used at the time of starting and travelling the distance equal to the vehicle's length. and to Pierwszy z nich zgodnie ze wskazaniem producenta zawartym w instrukcji obsługi użyty ma być do ruszenia i pokonania odległości równej długości pojazdu. Then the remaining gears are used depending on conditions. Observing by a driver of the rule, that higher gears should be used what is connected with economy of drive referred to fuel consumption and the progressing degree of an engine's wearing out is a common recommendation. Considering the above as the exploitative conditioning concerning the vehicle transmitted a driver/ user/ it may be assumed, that there occurs a considerable divergence between



correct exploitation of the means of transport and the road as an element of infrastructure prepared for it. The divergences prove:

- unfavourable consumption of fuel in the realized run,
- interference in a higher level than in the natural environment,
- wear and tear of an engine because of performing a higher number of work cycles,
- lower comfort of travel because of a higher level of noise generated by the engine.

It results from the above facts, that in practice each passenger vehicle in road conditions occurring in Poland is exploited at variance with the manual and a producer's instructions. Such a state of affairs undoubtedly leads to specific conduct of drivers whom commonly irregularities in conduct are being pointed out.

## REFERENCES

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