

THE ISSUE OF DETERMINATION OF TRAFFIC VOLUMES ON URBAN ROADS

PROBLEMATIKA VÝPOČTU INTENZIT DOPRAVY NA MÍSTNÍCH KOMUNIKACÍCH

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Abstract

The paper describes the partial outputs of the project focused on measuring the intensity of transport flows and improvement of the methodology for determining these intensities on roads in the urban areas. The presumption was that the current methodology for determining the traffic intensities cannot be applied to the specific types of traffic on selected urban roads. The aim of the traffic surveys and subsequent analysis was to find ways to adjust the methodology for determining the traffic intensities so that it can be used on urban roads with a specific types of traffic.

Abstrakt

Příspěvek pojednává o dílčím výstupu projektu zaměřeného na měření intenzit dopravy a zpřesnění metodiky výpočtu těchto intenzit na pozemních komunikacích na území města. Je zde předpoklad, že současné technické podmínky, respektive metodika výpočtu intenzit, nelze aplikovat na charakter provozu na vybraných místních komunikacích. Cílem dopravního měření a následné analýzy bylo nalézt rámcové možnosti, jak stávající metodiku výpočtu intenzit upravit tak, aby ji bylo možno použít i na místní komunikace se specifickým charakterem provozu.

Keywords

Traffic Intensities, Urban Roads, TP 189, Annual Average Daily Traffic, AADT

Klíčová slova

Intenzity dopravy, místní pozemní komunikace, TP 189, Roční průměr denních intenzit

INTRODUCTION

The traffic intensity is the main measure of roadway capacity. Mostly it is given by daily traffic intensity, which represents the number of vehicles that will pass through one point of the road in both directions for 24 hours (in one day). Another important indicator of the traffic intensity is called Annual Average Daily Traffic (AADT) for given section of a road, which is the number of vehicles, which on average will pass through the section of the road in both

directions in the working day for 24 hours. Size indicator of traffic intensity of is AADT [cars / 24h].

In more detail the problems of conducting the surveys, evaluation of surveys, AADT determination, daily intensities or hourly peak intensities are described in the document of Technical condition no. 189 (TP 189) entitled "Determination of traffic volumes on the roads." with the help of conversion coefficients.

Now the current conversion coefficients are given for each category of roads. They appear to be inefficient tool for calculation of intensity in the category of local roads, which reflects the actual state of operation of a different character according to the surrounding buildings and the use of the urban area. Another important document is the technical conditions no. 225 (TP 225) entitled "Prognosis of the intensity of car traffic", which were analyzed as part of the project as well.

IMPLEMENTATION OF TRAFFIC SURVEYS

In November 2014 the measuring of traffic intensity on local urban roads was held in cooperation with company B & C Transport Systems, Ltd. and The Institute of Technology and Business in České Budějovice. The aim of the project was to analyze the present technical conditions, dealing with procedures for calculating the intensity on all roads. Measurements were carried out on local urban roads and selected roads of I. and II. classes in the territory of České Budějovice, together with measurements in other towns.

Realization of measurement and analysis of the achieved data was the basis for evaluation of the existing legislative instruments to determine the output protocol of AADT (annual average daily traffic). An essential tool (and therefore decisive for determining the AADT) is the method of sensing the actual values and their processing in accordance with the procedure defined in TP 189 and TP 225. Both procedures are a fundamental tools for the evaluation of measurement results. Research team conducted planned measurements in selected cities to obtain the real data, which were compiled into the output formats in accordance with the aforementioned "technical conditions". Consequently, they were compared and analyzed. Values in the form of tabular ratio coefficients diverge significantly for different types of vehicles, roads, seasons in city traffic on urban roads. Realized measurement of the traffic intensities and their relevance are the basis for determining the actual traffic volumes. Each measurement must capture the most accurate and verifiable number of vehicles that are passing through the measured section. It is also significant to define measuring section. The selected sections must reflect the current traffic needs and needs of city population and must be generalized in all the selected cities. It regards the establishment of general principles for the selection of the measurement points and the definition of social mobility needs of the population.

Strong emphasis was placed on the verifiability of the measurement and the results. B&C Transportation Systems Ltd. owns measuring devices that are capable of capturing a movements of vehicles at selected road section in provable way. It is a device that based on ultrasound technology captures all passing vehicles. Measuring the intensity is then possible to realize in longer time periods and the results more accurately evaluated. It is mainly the possibility of measuring the intensity in reduced visibility (night period). Authenticity of record of the actual number of vehicles is proved by the timestamp of each passing vehicle and its speed. Thus it is possible to precise allocation of vehicles to defined types, which is required

by the applicable technical conditions TP 189. Realized measurement was planned for a period 12 to 24 hour measurements in order to fully capture the day's traffic volume. The obtained values were analyzed after defined time periods and then compared with the calculation according to Technical conditions. The measured values for a defined period of measurement have become the default for comparing the coefficients defined by Technical conditions for local roads and tertiary roads marked as "M" and the roads adjoining the parking areas by the commercial and business zones (usually a special-purpose roads) marked as "Z".

According to the initial results we can say that the categorization of roadways in towns under the current technical conditions is too general and does not reflect the specifics of the transport system of the city. It is a fact that the current TP 189 and TP 225 are designed mainly to determine the value of traffic intensity on roads defined as categories D, R, I, II - the intercity traffic. Local and special roads generally define roadways in the city, but currently it is necessary to define further the importance of local and tertiary roads. It is obvious that the classic categories of local roads according to law no. 13/1997 is also not an appropriate categorization for the determination of traffic volumes in terms of different traffic characters in the city.

Research team also pays an attention to other factors that affect the transport needs of the population. The basis of preparation of measurement plan was to analyze all major destinations of population mobility. The fact is that the diversification of starting work time in various companies, business hours of shopping malls, working hours of administrative institutions and healthcare facilities significantly affects the whole process of required mobility of the population.

ANALYSIS OF DATA FROM MEASUREMENTS OF THE INTENSITY

Realized measurements were subjected in all points of measurement to detailed analysis of the actual values of the individual coefficients and coefficients according to the TP 189. The results show that there is indeed a significant difference especially for measurements on local roads in cities. A very important factor is the definition of the final destinations of the population mobility and reason of using the local roads.

Primary consideration for selecting local roads for measuring the traffic intensity was the fact that roads in the city each have different specific traffic character according to the town planning and economic character of the surrounding buildings - for example the daily variations of the traffic intensity will be different for special local roads and local roads with mixed traffic, daily variation of traffic intensity will also vary with the local road linking the industrial zones of the city (due to the shift operation) or for local access roads to the schools, student dormitories, administrative institutions etc. We can identify different specific operations on local roads, of which for the initial phase of measurement and subsequent analysis were the following:

- the access roads for shopping centers,
- local roads in residential areas,
- local roads with administrative centers,
- fast local roads,
- local roads linking industrial zones.

Based on the determination of these types of local roads it is necessary to determine the new values of p_i^d , which will reflect the values relevant to a conversion coefficients according to the actual character of the traffic on the road and it is possible to determine them according to the daily variation of traffic intensity (weekly variations, yearly variations, etc.). It also means the future intervention into the existing methodology – to change current Technical conditions TP 189.

According to the above-mentioned proposal for the distribution of local roads the roadways in the city of České Budějovice were selected on which the pilot measurements were carried out. From the data obtained during the traffic surveys were drawn graphs indicating the number of passing vehicles in dependence on time. From these graphs and measured values can be seen the traffic characteristics specific to the selected roads in the city.

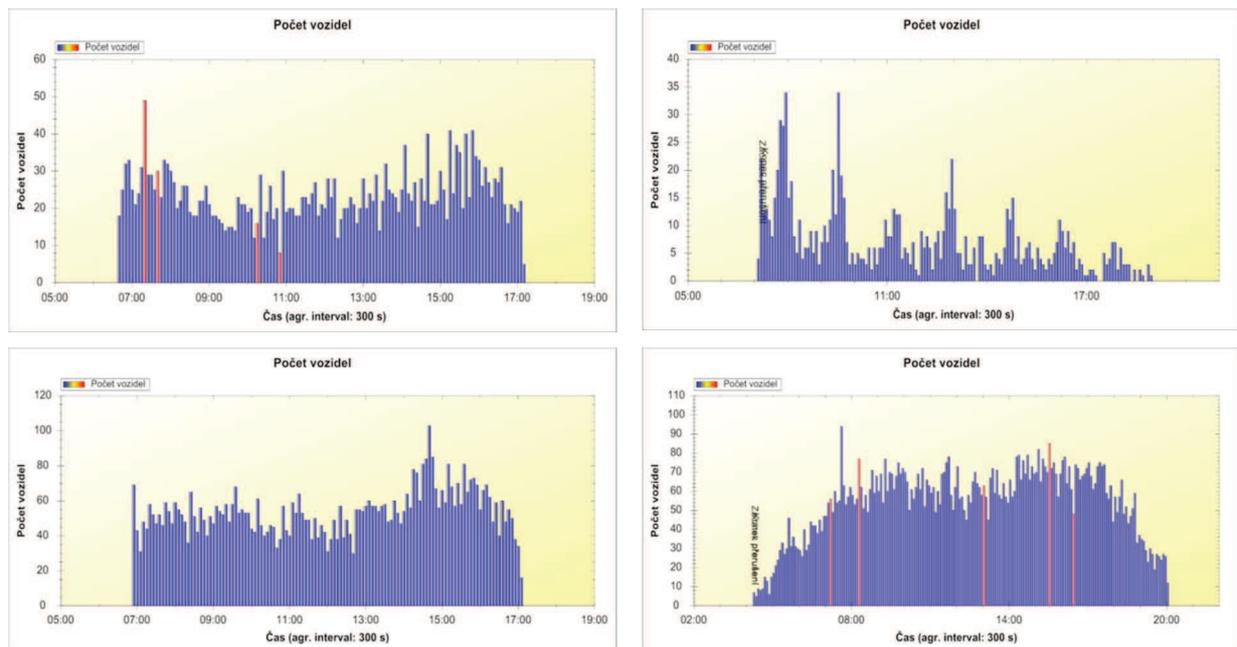


Figure 1 – Graphical output of measurements in the profiles of local roads with different specific characters traffic. Source: Authors

For purposes of analysis of methodology for determining the daily variation of intensities the shares of cars in total course of the reporting period were determined (measurements were carried out according to each hours of the day). These shares indicate to us the conversion coefficients, thanks to which can be determined the daily variation of traffic from the data obtained during the measurement.

The following table and diagram output (Figure 2) shows comparison of converted coefficients from measured data and conversion coefficients set by current methodology (TP 189) for calculations of daily intensities generally on all roads, both in urban and in rural areas. The scheme demonstrates the significant deviation of the set out coefficients and converted coefficients at the measuring points, in this case on a local service road in the residential area.

Počátek intervalu	Počet vozidel	Podíl [%]	Kum. podíl [%]	Koef. Denní variace TP 189 OA
6:48:41	623	9,4	9,4	4,81
7:48:41	598	8	18,4	6,79
8:48:41	500	7,5	25,9	6,66
9:48:41	506	7,6	33,5	6,36
10:48:41	499	7,5	41	6,28
11:48:41	486	7,3	48,3	6,13
12:48:41	455	6,8	55,2	6,22
13:48:41	619	9,3	64,5	6,51
14:48:41	744	11,2	75,7	7,36
15:48:41	752	11,3	87	8,15
16:48:41	467	7	94	7,92
17:48:41	357	5,4	99,4	7,04
18:48:41	42	0,6	100	5,62

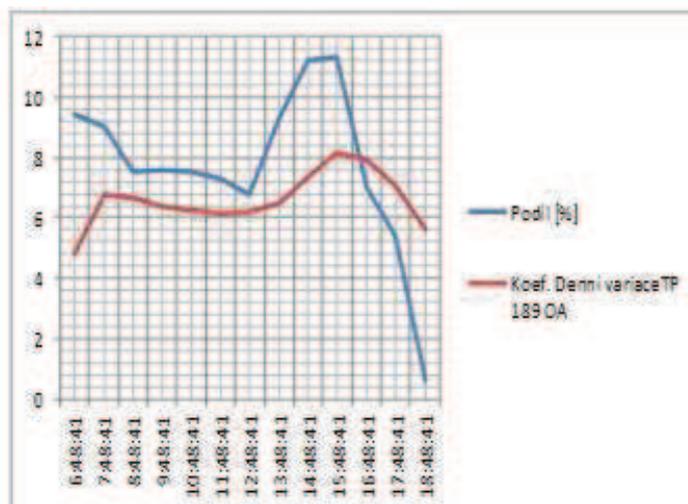


Figure 2 - Table and graph comparing the coefficients of Daily variation - REALITY (blue curve) vs. TP 189 methodology at Jírovcova street in České Budějovice. Source: Authors

ANALYSIS OF INFLUENCE OF TIME-LIMITED MEASUREMENT OF THE INTENSITY ON THE URBAN ROADS IN ČESKÉ BUDĚJOVICE AND A COMPARISON OF MEASUREMENT RESULTS WITH THE METHODOLOGY OF CALCULATING THE DAILY INTENSITY ACCORDING TO TP 189

From the measurement results (the intensity gained at the relevant time measurement - I_m) were compiled tables expressing the frequency of vehicles in hourly intervals. According to the type of communication, day hour of measurement and season were used the values of the shares of intensities for exact hour for vehicles in total (according to TP 189). Using equation (1) the values of conversion factors for each type of local road were determined and the daily traffic volume was then for the "total vehicle" determined according to formula (2). These formulas can be found in TP 189, which directly regulates the calculation methodology for all roads. Values of conversion coefficients $k_{m,d}$ for any selected time period of the survey is determined by the relationship:

$$k_{m,d} = \frac{100\%}{\sum p_i^d}, \quad (1)$$

where:

$\sum p_i^d$ is the sum of the shares of hourly traffic volumes during the survey on a daily traffic volume [%]. Recommended values p_i^d are determined for each types of vehicles and traffic characters in annexes of TP 189, where may also be found the coefficients $k_{m,d}$ for the recommended time of the survey.

Daily traffic intensity is determined for each type of vehicle (or vehicles in total) using the formula:

$$I_d = I_m \cdot k_{m,d}, \quad (2)$$

where:

I_d is a daily traffic volume in the day of the survey [cars/day],

I_m is the traffic volume gained at the time of the survey [cars/time period],

$K_{m,d}$ is a conversion coefficient of traffic intensity at the time of the survey on a daily traffic volume (taking into account the daily variations in traffic according to TP 189).

Mutually comparison of the results of daily intensities for specific time intervals according to TP 189 can be concluded that these values are different, and quite significantly. For example, if we look at the values shown in Table. 1, it is evident that according to the each hour segments can not be applied the conversion coefficients which are used by the TP 189 for calculations of traffic volumes on local roads near commercial zones. Basically, the value of the I_d for each hour sections should be the same as the value of I_d in 24 hours, or it is as close as possible (marked in red text in tables). It is similar with other roads in the city, where the values are shown in Table no. 2, 3 and 4. It can be noted that the recommended values p_i^d of TP 189 (ratio of intensity of each hour i on a daily traffic volume) can not be applied to certain types of local roads with a specific traffic. This observed deviation may also be caused by several factors, but mainly by the small sample of input data. Measurements will necessary to be repeated several times and measure the passing vehicles for at least 24 hours at each station, to have the opportunity to work with a more representative sample of data. Then the measurement results have a greater explanatory power and would be more objective for the partial conclusions or for further work with the data.

Table 1 - Converted coefficients and daily traffic volume on a local road near commercial zones.

Road/Hour	11. 11. 2014 Commercial zone Globus			I_d [cars/24 h] (M)
	p_d^i (M)	$K_{m,d}$ (M)	I_m [cars/time period]	
7h - 8h	6,79	14,7275405	179	2636,22975
8h - 9h	6,75	14,81481481	476	7051,851852
9h - 10h	6,66	15,01501502	698	10480,48048
10h - 11h	6,56	15,24390244	787	11996,95122
11h - 12h	6,37	15,69858713	933	14646,78179
12h - 13h	6,35	15,7480315	871	13716,53543
13h - 14h	6,69	14,94768311	791	11823,61734
14h - 15h	7,41	13,49527665	918	12388,66397
15h - 16h	7,89	12,67427123	1085	13751,58428
16h - 17h	7,51	13,31557923	1083	14420,7723
17h - 18h	6,61	15,12859304	932	14099,84871
18h - 19h	5,32	18,79699248	550	10338,34586
Cars in total:			9303	
$K_{m,d}$ (5h-20h) [cars/ reference period] M:			1,235941169	
I_d [cars/24 h] M:			11497,9607	

Source: authors, own findings and data

Table 2 - Converted coefficients and daily traffic volume on the road of II. class - in the city.

Road/Hour	13. 11. 2014 Pražská street			I _d [cars/24 h] (II-S)
	p _d ⁱ (M)	k _{m,d} (II-S)	I _m [cars/time period]	
7h - 8h	6,69	14,94768311	1666	24902,84006
8h - 9h	6,84	14,61988304	1452	21228,07018
9h - 10h	6,6	15,15151515	1399	21196,9697
10h - 11h	6,43	15,55209953	1269	19735,61431
11h - 12h	6,16	16,23376623	1187	19269,48052
12h - 13h	6,28	15,92356688	1297	20652,86624
13h - 14h	6,81	14,68428781	1250	18355,35977
14h - 15h	7,72	12,95336788	1478	19145,07772
15h - 16h	8,22	12,16545012	1586	19294,40389
16h - 17h	7,63	13,1061599	1444	18925,29489
17h - 18h	6,51	15,3609831	1165	17895,54531
18h - 19h	4,98	20,08032129	878	17630,52209
Cars in total:			16071	
k_{m,d} (5h-20h) [cars/ reference period] II-S:			1,236552492	
I_d [cars/24 h] II-S:			19872,63509	

Source: authors, own findings and data

Table 3 - Converted coefficients and the daily traffic volume determined on the road II. class - tangential character of transport in the city..

Road/Hour	12. 11. 2014 – Okružní street			I _d [cars/24 h] (II-S)
	p _d ⁱ (M)	k _{m,d} (II-S)	I _m [cars/time period]	
7h - 8h	6,69	14,94768	1204	3856,502242
8h - 9h	6,84	14,61988	1306	2192,982456
9h - 10h	6,6	15,15152	1277	3878,787879
10h - 11h	6,43	15,5521	1096	1912,908243
11h - 12h	6,16	16,23377	1129	3798,701299
12h - 13h	6,28	15,92357	1512	2738,853503
13h - 14h	6,81	14,68429	1652	2437,591777
14h - 15h	7,72	12,95337	1526	2538,860104
15h - 16h	8,22	12,16545	1391	1849,148418
16h - 17h	7,63	13,10616	1336	3289,646134
17h - 18h	6,51	15,36098	760	2135,176651
18h - 19h	4,98	20,08032	459	2048,192771
Cars in total:			14648	
k_{m,d} (5h-20h) [cars/ reference period] II-S:			1,236552492	
I_d [cars/24 h] II-S:			18113,0209	

Source: authors, own findings and data

Table 4 - Conversion coefficients and the daily traffic volume determined on a local road - near the administrative center of the region.

Road/Hour	12. 11. 2014 – Acces road to VŠTE			I_d [cars/24 h] (M)
	p_d^i (M)	$k_{m,d}$ (M)	I_m [cars/time period]	
7h - 8h	6,79	14,7275405	258	3799,705449
8h - 9h	6,75	14,81481481	150	2222,222222
9h - 10h	6,66	15,01501502	256	3843,843844
10h - 11h	6,56	15,24390244	123	1875
11h - 12h	6,37	15,69858713	234	3673,469388
12h - 13h	6,35	15,7480315	172	2708,661417
13h - 14h	6,69	14,94768311	166	2481,315396
14h - 15h	7,41	13,49527665	196	2645,074224
15h - 16h	7,89	12,67427123	152	1926,489227
16h - 17h	7,51	13,31557923	251	3342,210386
17h - 18h	6,61	15,12859304	139	2102,874433
18h - 19h	5,32	18,79699248	102	1917,293233
Cars in total:			2199	
$k_{m,d}$ (5h-20h) [cars/ reference period] M:			1,235941169	
I_d [cars/24 h] M:			2717,834631	

Source: authors, own findings and data

Realized measurements were subjected in all points of measurement to detailed analysis of the actual values of the individual coefficients and coefficients according to the TP 189. The results show that there is indeed a significant difference especially for measurements on local roads in cities. A very important factor is the definition of the final destinations of the population mobility and reason of using the local roads.

CONCLUSION

The authors of the contribution analyzed existing TP 189 and TP 225. These technical guidelines are the basis for the determination and calculation of Annual Average Daily Traffic (AADT). The basic tool is a set of coefficients that are derived from practical measurements. Based on the findings of some shortcomings arising from the analysis the measuring of the traffic intensities was done, which confirmed the primary considerations. It is true that actuality of some values (on which the model of AADT is assembled) does not reflect reality and actually measured traffic volumes, especially in the context of calculations of AADT on local roads.

It was found that both intensities are different for each local communications with the specific character of traffic, and are significantly different even over the day compared to intensities in rural roads. It is all about the intensity of morning and afternoon intensity. The aim of the project was not to make judgments about the values of hourly coefficients of intensity (see by TP 189), but investigators show that the update of the TP 189 will be required in the future.

LITERATURE

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