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EVALUATION OF ROAD TRAFFIC SAFETY LEVEL IN THE STATE MAIN ROAD NETWORK OF LATVIA

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Abstract. Evaluation of road traffic safety level may be done using several methods. The methods of accident rate and accident frequency used in this paper provide an opportunity to analyze dangerous road sections on all state main roads of Latvia. Latvia has 15 state main roads, they lead through 24 out of 26 districts, and their total length in Latvia is 1740.8 km. Analysis of road traffic accident statistics was carried out basing on the data available at Road Traffic Safety Directorate for the time period of three years (2005–2007). Critical value of accident rate has been calculated for state main roads network and its numerical value is 1.81 accidents per 10^6 vehicle km. Besides, relation between traffic intensity and accident rate for state main road network of Latvia has been achieved as well.

Keywords: state main rate roads, accident rate (*AR*), accident frequency (*AF*), dangerous road sections.

1. Introduction

Widely in the world to analyse and estimate an accident situation in civil engineering many different methodologies and methods are used (Giretti *et al.* 2009; Hoła 2009; Zavadskas, Vaidogas 2008; 2009). Different methods for the evaluation of sustainable safety (Vaidogas, Juocevičius 2008) and road traffic safety level may be used to determine dangerous sections on roads (Kapski 2006; Kapski *et al.* 2007; Lama *et al.* 2006). One of the most frequently used criteria for safety evaluation not only on roads is accident frequency (*AF*) and accident rate (*AR*) (Hoła 2007; Sokolovskij 2007; Šliupas 2009).

The analysis done by authors covers the state main road network in Latvia. The function of the state main roads is to provide connections with foreign countries and capital cities of foreign countries. Latvia has 15 state main roads, they lead through 24 out of 26 districts, and their total length in Latvia is 1740.8 km.

Analysis of road traffic accident statistics was carried out basing on the data available at Road Traffic Safety Directorate for the period of three years (2005–2007).

2. Accident frequency

One of the most frequently used analytical methods for determining the road traffic safety level is the calculation of *AF*. This value was determined for every km of state main roads.

$$AF = \frac{Acc}{L \times T}, \tag{1}$$

where AF – accident frequency, accident/km); Acc – number of road traffic accidents per 3 years; L – length of analysed road section, 1 km; T – reviewed time period, 3 years.

Usually road sections with similar technical parameters are chosen and average frequency of accidents (AF_{ave}) is calculated for each road section:

$$AF_{ave} = \frac{\sum_{i=1}^{n} AF_i}{n}, \tag{2}$$

where AF_{ave} – average frequency of accidents, accidents/km; AF_i – total number of *AF* in specific section, accidents/km; n – number of sections in general group.

According to *PIARC Road Safety Manual* the accident frequency limit value is determined which will be regarded as the min dangerous accident frequency AF_{lim}:

$$AF_{\text{lim}} = 2 \times AF_{ave}. \tag{3}$$

After determining the *AF* for all sections it is compared with AF_{lim}. With this approach the most dangerous road sections according to *AF* are determined.

3. Accident rate

The *AR* was determined that characterised the risks to which road users are subjected in a certain road section. The *AR* was calculated for each road section, as well.

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$$AR = \frac{Acc \times 10^6}{365 \times L \times T \times N}, \quad (4)$$

where AR – accident rate, accidents/vehicle km × 10^6; Acc – number of road accidents per 3 years; L – length of reviewed section, 1 km; T – reviewed time period, 3 years; N – annual average daily traffic ($AADT$) vpd.

The formula given in the *PIARC Road Safety Manual* is used to determine the limit value of AR; if this value is exceeded it may be stated that the analysed road section is dangerous to traffic:

$$AR_{crit} = AR_{ave} + \frac{1 \times 10^6}{730.5 \times T \times L \times N} + C\sqrt{\frac{AR_{ave} \times 10^6}{365.25 \times T \times L \times N}}, \quad (5)$$

where AR_{crit} – critical value of AR, accidents/vehicle km × 10^6; AR_{ave} – average value of AR in specific road network, accidents/vehicle km × 10^6; T – reviewed time period, 3 years; L – length of reviewed section, 1 km; N – $AADT$, vpd (for the state main roads $AADT$ = 5305 vpd); C – statistical constant with 95% level of confidence (C = 1.645).

4. Accident frequency and critical accident rate

Basing on the formula given before Eq (3) and Eq (5) AF_{lim} and AR have been found.

Table 1 shows the data on average value of AR_{ave} and AF_{ave} for each state main road. AR_{crit} indicates the limit value of AR which was calculated with respect to the whole state main road network. AF_{lim} indicates the critical value of accident frequency for the whole state main road network.

Relation between traffic volume and AR in the state main road network (Fig. 1) may be expressed as follows:

$$AR = 1.23364655 - 0.00003516 \times N. \quad (6)$$

Fig. 2 shows that in 99.14% of cases the AR value is in limits between 0 and 5. Reviewing the distribution of AR values we may conclude that at 50% the AF value is approx 0.56 and at 85% the AF value is 1.46.

8846 road traffic accidents have occurred on state main roads in 2005–2007. Out of them 1809 accidents were heavy accidents, 405 persons were killed and 2526 injured.

Considering the AF, the road with the worst properties (AF = 5.74) is the road A4 Rīga bypass (Baltezers–Saulkalne), however, considering the AR, the road with the worst properties (AR = 1.96) is the state road A12 Jēkabpils–Rēzekne–Ludza–Russian border (Terehova).

5. Practical use of accident frequency and accident rate

According to the formulas reviewed above, the AF and the AR was determined for every km of state main roads.

Table 1. AR_{ave} and AR_{ave} on Latvian main roads in 2005–2007

Road No.	Number of				AF_{ave}	AR_{ave}
	accidents	heavy accidents	fatalities	injured		
A1	630	123	28	175	2.04	1.05
A2	937	192	46	276	1.58	0.98
A3	475	100	20	142	1.28	0.94
A4	380	82	15	140	5.74	1.56
A5	460	75	23	106	3.62	1.05
A6	1563	328	69	461	1.69	0.86
A7	590	141	30	199	2.26	0.62
A8	505	132	40	138	2.16	0.73
A9	926	203	49	294	1.54	0.99
A10	997	211	33	313	1.75	0.71
A11	111	17	2	24	0.67	1.00
A12	747	103	27	127	1.48	1.96
A13	485	95	19	124	0.97	1.28
A14	33	6	2	5	0.65	1.10
A15	7	1	2	2	0.26	0.48
Total	8846	1809	405	2526	1.67	1.03
AF_{lim}					3.34	
AR_{crit}						1.81

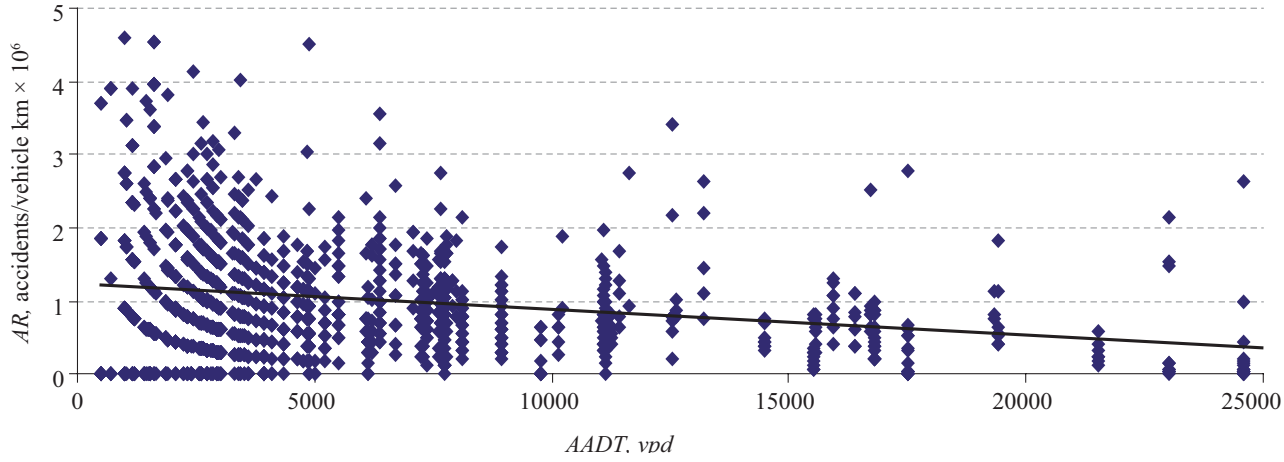

Fig. 1. Relation between traffic volume and *AR* on state main roads

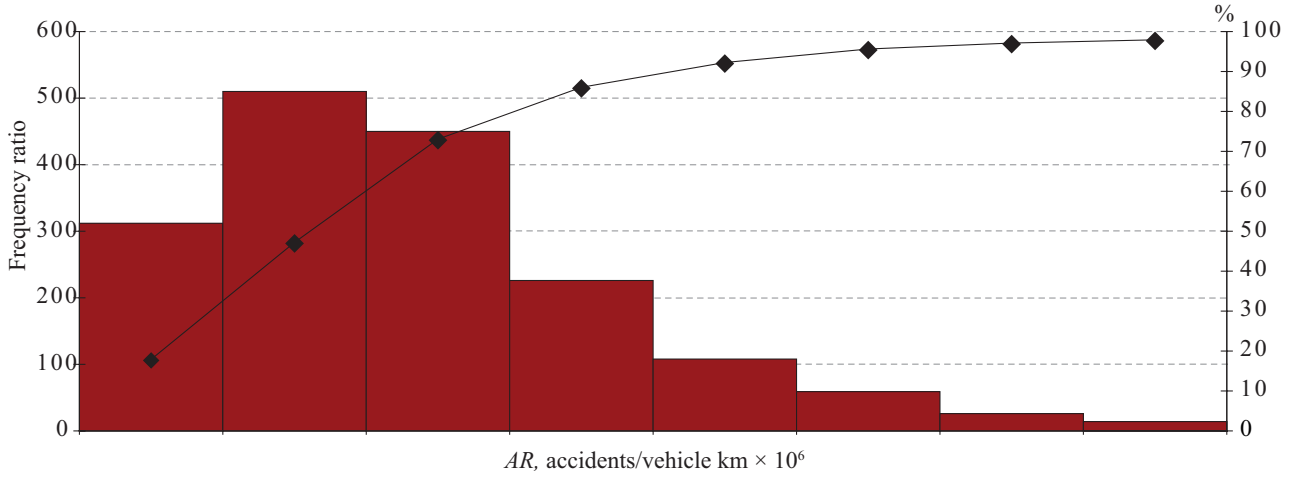

Fig. 2. Histograme and cumulative dencity function of *AR*

As an example the calculations of one state main road A4 Rīga bypass (Baltezers–Saulkalne) may be reviewed.

Characteristics of the existing roads:

Road A4 is located in Rīga district. Total road length is 20.4 km. Max permitted driving speed outside urban areas is 90 km/h, in urban areas 70 km/h and 50 km/h. In 2005 the *AADT* on road A4 is shown in Fig. 3.

Analysis of statistical material was done base on the data available at Road Traffic Safety Directorate for three years (2005–2007).

380 accidents happened in the reviewed time period: 82 were heavy road accidents, 15 persons were killed and 140 injured.

In the Table 2 the values of *AR* are given which were determined according to Eq (4). To determine which road sections are dangerous for traffic the AR_{crit} was calculated for the whole network of state main roads according to Eq (5) and $AR_{crit} = 1.18$.

Fig. 4 shows those road sections on state main road A4 where the values of accident factor exceed critical limit values, therefore these road sections may be regarded as dangerous for traffic.

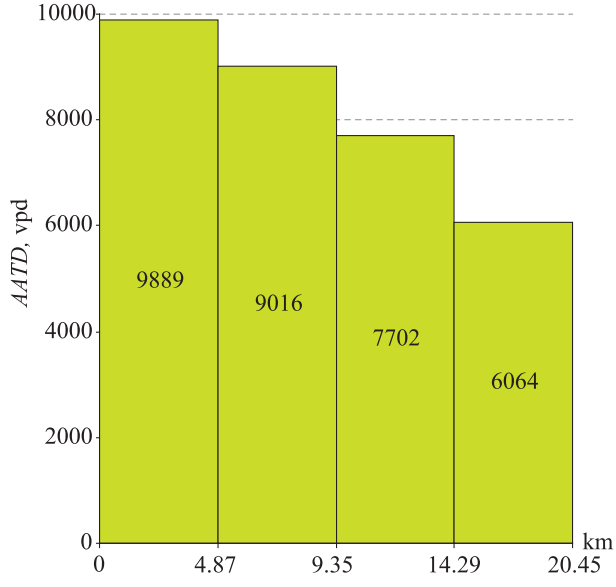

Fig. 3. *AADT* on state main road A4 Rīga bypass (Baltezers–Saulkalne)

Table 2. Analysis of road traffic accidents on road A4 in 2005–2007

Road km	Number of				*AF*	*AR*
	accidents	heavy accidents	fatalities	injured		
0	86	23	3	46	28.67	5.94
1	32	6	0	10	10.67	2.21
2	16	2	0	4	5.33	1.11
3	21	4	1	4	7.00	1.45
4	11	2	0	2	3.67	0.76
5	38	8	1	11	12.67	2.63
6	21	2	0	9	7.00	1.68
7	10	2	1	4	3.33	0.80
8	16	6	3	13	5.33	1.28
9	14	4	0	9	4.67	1.12
10	8	2	0	2	2.67	0.64
11	7	1	0	1	2.33	0.90
12	15	3	0	6	5.00	1.94
13	15	1	0	1	5.00	1.94
14	13	0	0	0	4.33	1.68
15	10	3	1	3	3.33	1.29
16	5	3	1	2	1.67	0.75
17	11	2	2	1	3.67	1.65
18	16	4	2	4	5.33	2.40
19	5	1	0	2	1.67	0.75
20	5	2	0	2	1.67	0.75
21	4	1	0	4	1.33	0.60
Total	380	82	15	140	5.74	1.56

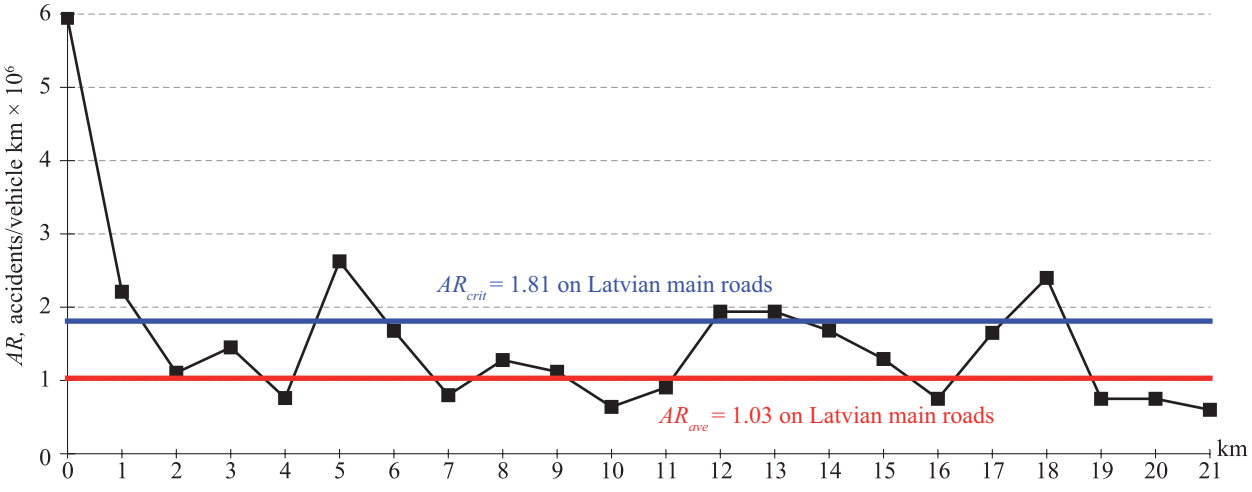

Fig. 4. *AR* in road A4 Rīga bypass (Baltezers–Saulkalne) in 2005–2007

6. Conclusions

The values of AR_{crit} and $AF_{\lim}$ calculated in this paper provide an opportunity to identify dangerous road sections. Calculated values of *AR* and *AF* provide an opportunity to define priorities for the needs to reconstruct dangerous road sections in the state main road network of Latvia.

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