Assessment of road traffic safety level on Latvia's main highways

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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 analyse dangerous road sections on all state main roads of Latvia.

Key words: accident rate, accident frequency, dangerous road sections.

1. Introduction

Different methods for the evaluation of traffic safety level may be used to determine dangerous sections on roads. Most frequently used properties of traffic safety level is accident frequency and accident rate [1, 2, 4 – 6].

The analysis covers the state main road network. 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 (Acc) 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 accident frequency [2]. Formula 1 has been used to calculate the accident frequency - AF. This value was determined for every kilometre of state main roads.

$$AF = \frac{Acc}{L \times T} \quad (1)$$

where AF – accident frequency (accident per 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 number of accidents is calculated for each road section.

$$AF_{ave} = \frac{\sum_{i=1}^{n} AF_i}{n} \qquad (2)$$

where AF_i – total number of accident frequency in specific section (accidents per km);

n – number of sections in general group;

AF_{ave} – average frequency of accidents (accidents per km).

According to references /2/ the limit value is determined which will be regarded as the minimum dangerous accident frequency AF_{lim}:

$$AF_{\lim} = 2 \times AF_{ave} \qquad (3)$$

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

3. Accident rate

Basing on the formula given in the literature /2/ the *accident rate AR* was determined that characterised the risks to which road users are subjected in a certain road section. The accident rate was calculated for each road section, as well.

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

where AR – accident rate (accidents per million vehicle kilometres);

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 (vehicles per 24h).

The formula given in the literature /2/ is used to determine the limit value of accident rate (AR); if this value is exceeded it may be stated that the analysed road section is *dangerous to traffic*:

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

where AR_{crit} – critical value of accident rate (accidents per 10^6 vehicle km);

AR_{ave} – average value of accident rate in specific road network (accidents per 10^6 vehicle km);

L – length of reviewed section - 1 km;

T – reviewed time period - 3 years;

N - annual average daily traffic– 5305 vehicles per 24h for the state main roads.

K – statistical constant (with 95% reliability level)

85% reliability level K=1.036

90% reliability level K=1.282

95% reliability level K=1.645

99% reliability level K=2.326.

4. Accident frequency AF_{lim} and accident rate AR_{crit}

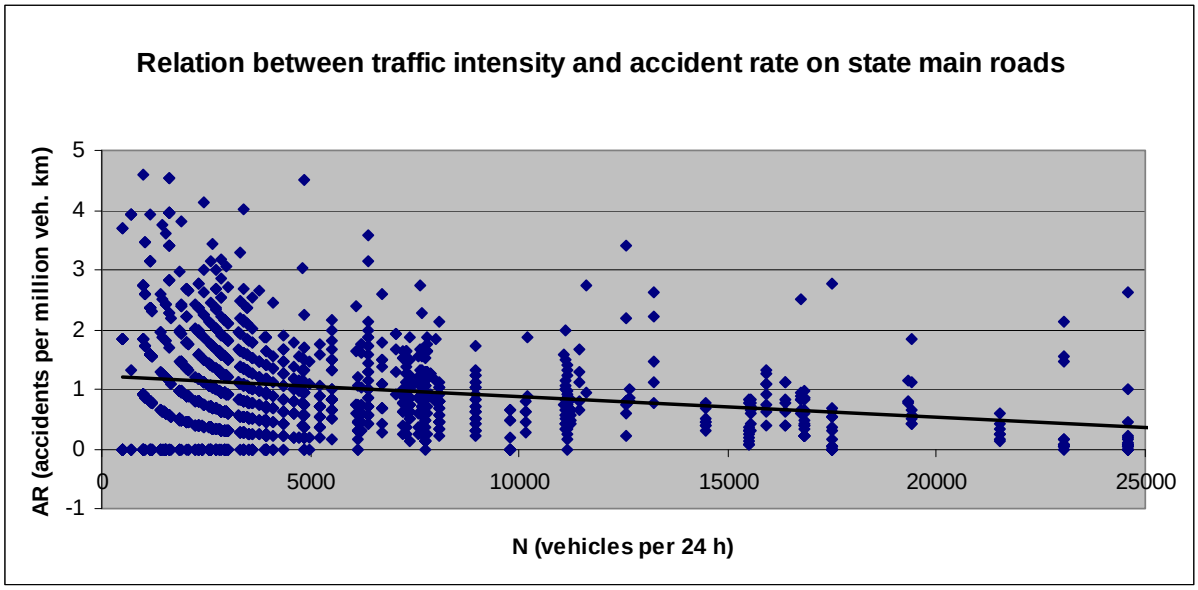
Basing on the formula given before (3) and (5) minimum dangerous accident frequency AF_{lim} and critical accident rate has been found.

Table 1 shows the data on average value of accident rate AR_{ave} and accident frequency AF_{ave} for each state main road. AR_{crit} indicates the limit value of accident rate 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.

Table 1: Average rate of accident rate and accident frequency

Time period 2005 – 2007						
Road No.	**Acc.**	**Heavy acc.**	**Fatalities**	**Injured**	**AF_{ave}**	**AR_{ave}**
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**	**Ave = 1.67**	**Ave = 1.03**
AF_{lim}					**3.34**	
AR_{crit}						**1.81**

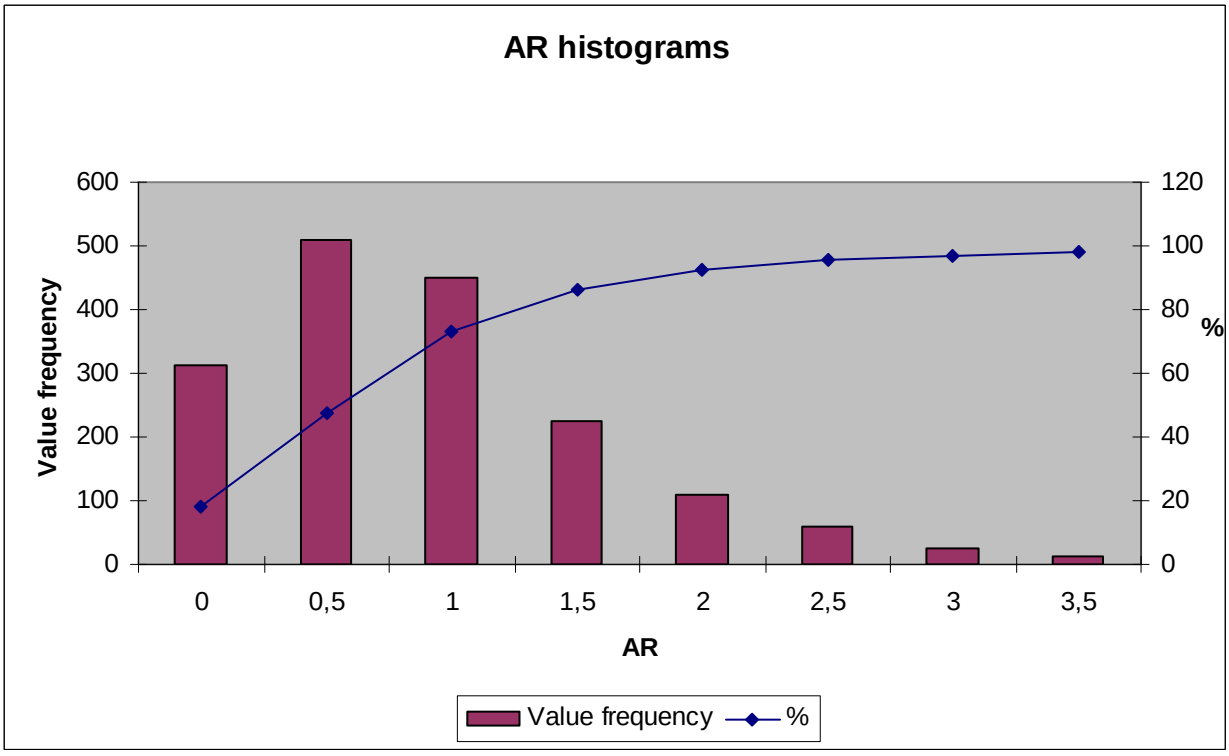
Figure 1: Relation between traffic intensity and accident rate



Relation between traffic intensity and accident rate in the state main road network may be expressed as follows:

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

Figure 2: Accident rate histograms



AR column diagram 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 approximately 0.56 and at 85% the AF value is 1.46.

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

Considering the accident frequency AF, the road with the worst properties (AF = 5.74) is the road A4 Riga bypass (Baltezers – Saulkalne), however, considering the accident rate 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 accident frequency AF and the accident rate AR was determined for every kilometre of state main roads.

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

Characteristics of the existing roads:

Road A4 is located in Riga district. Total road length is 20.4 km. Maximum permitted driving speed outside urban areas is 90 km/h, in urban areas 70 km/h and 50 km/h. In 2005 the annual average daily traffic on road A4 is shown in Table 2.

Table 2: Annual average daily traffic on road A4

State main road A4 Riga bypass (Baltezers – Saulkalne).	From km	To km	AADT*
	0,0	4.87	9889
	4.87	9.35	9016
	9.35	14.29	7702
	14.29	20.45	6064

*AADT – annual average daily traffic

Maximum permitted driving speed outside urban areas is 90 km/h, in urban areas 70 km/h and 50 km/h.

Table 3: Analysis of road traffic accidents on road A4

	Road km	Acc.	Heavy acc.	Fatalities	Injured	*AF*	AR
2005 – 2007	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**

Analysis of statistical material was done basing 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.

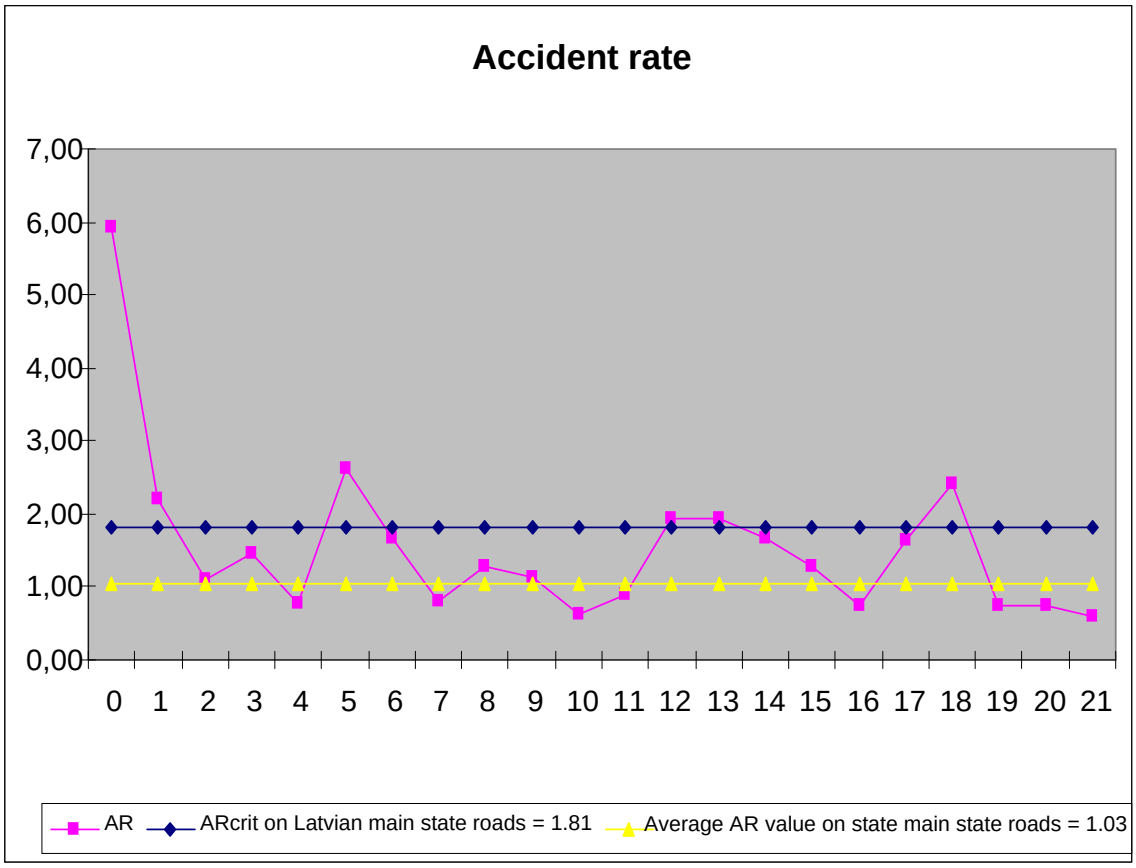
In the right column of Table 3 the values of accident rate AR are given which were determined according to formula (4). To determine which road sections are dangerous for traffic the critical value of accident rate was calculated for the whole network of state main roads according to formula (5):

Critical value of accident rate AR_{crit} = 1.81,

where 95% reliability level is assumed for K (K=1.645).

Figure 3 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.

Figure 3: Accident rate



6. Conclusion

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

References

1. PIARC. Road Safety Manual. Recommendations from the World Road Association, 2004. 602 p.

2. SMIRNOVS, J.Kustības organizēšana un satiksmes drošība. Tālmācības materiāls. Rīgas Tehniskā Universitāte, Transportbūvju institūts, 2007. 114 p. (in Latvian).

3. KAPSKI Dz., LEONOVICH I., RATKEVICHIUTE K. Theoretical Principles of Forecasting Accident Rate in The Conflict Sections of the Cities by the Method of Potential Danger //"The Baltic Journal of Road and Bridge Engineering" Vilnius: Technika, 2007, Vol II, No 3, p. 133-140.

4. LAMA A., SMIRNOVS J., NAUDZUNS J. Road Traffic Safety in the Baltic States //"The Baltic Journal of Road and Bridge Engineering" Vilnius: Technika, 2006, Vol I, No 1, p. 63–68.

5. KAPSKI Dz., LEONOVICH I. Improvement of Road Traffic Safety on the Basis of Forecasting a Potential Danger in Places of Conflict Situations //"The Baltic Journal of Road and Bridge Engineering" Vilnius: Technika, 2006, Vol I, No 2, p. 83–92.