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ANALYSIS OF TRAFFIC SAFETY FACTORS AT LEVEL RAIL-ROAD CROSSINGS

ABSTRACT

The paper analyses the main factors of traffic safety and reliability at level crossings. The number and causes of accidents are stated, that result from ignorance, insufficient training of the traffic participants, their irresponsibility and insufficient or incomplete legislation, as well as from insufficiently professional and scientifically not serious enough approach to solving this cardinal problem in road and railway traffic. Based on the analysis the causes are determined and solutions proposed, as well as more efficient methods to improve safety and reduce the number of traffic accidents at level crossings.

KEY WORDS

level crossings, traffic safety, traffic accidents, traffic safety legislation

1. INTRODUCTION

Level crossings have primarily resulted from the development of continental traffic and roads over the last hundred-and-fifty years. When first railway and rail traffic appeared, it introduced new quality and quantity in traffic theory and practice of the modern society, but also new problems including the very significant problem of road and railway level crossings.

The problem of level crossings is basically of two kinds. The first and foremost problem of these critical points is that they represent a big and important hindrance in the free and undisturbed flow of road or rail traffic, since it is precisely at these points that one or the other get stopped, and this is usually road traffic. The second problem is that this is an incident point where, due to a wide range of reasons, accidents with all kinds of consequences occur.

It is precisely because of these two very important reasons that these problems simply have to be solved in the best way, in order to eliminate all or most of the negative, and most frequently fatal consequences caused by this incident condition at level crossings.

2. SITUATION REGARDING LEVEL CROSSINGS AT CROATIAN RAILWAYS (HRVATSKE ŽELJEZNICE - HŽ)

Croatian Railways have 2 680.795 km of rail tracks, and their classification is presented in Table 1.

Table 1

Ord.No.	HŽ tracks	Length (km)
1	a) trunk line	846.993
	b) branch line	690.889
	total (a+b)	1 537.882
2	1 st class	571.029
3	2 nd class	571.884
TOTAL (1+2+3)		2 680.795

On these lines, according to the data from December 31, 1998, the Croatian Railways had 1,616 such level crossings, and the data on the type and kind of how they are protected is presented in Table 2.

For easier reference the data from Table 2 are presented graphically in Figures 1a and 1b.

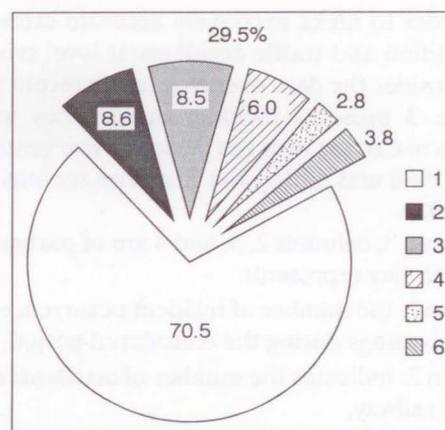


Figure 1a

Table 2

Ord. No.		CONDITION		
		Dec.31,96	Dec.31,97	Dec.31,98
1	LC protected by traffic signals (St.Andrew's cross, stop sign)	1 317	1 332	1 140
2	LC protected (flash lamps + ringing + half-barrier)	147	130	138
3	LC protected (flash lamps + ringing)	131	125	137
4	LC protected (barriers)	119	105	98
5	LC protected (flash lamps + ringing + half-barriers + crossing keeper)	47	43	40
6	pedestrian crossing with barriers	64	65	63
7	TOTAL (1+2+3+4+5+6)	1 825	1 800	1 616

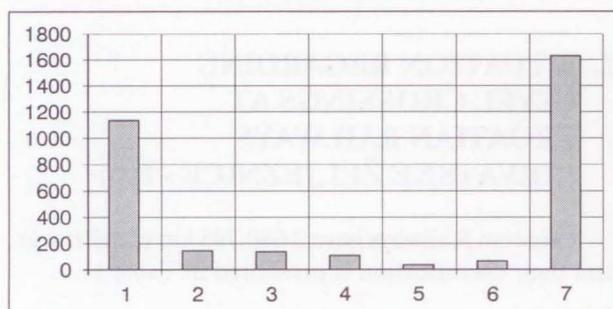


Figure 1b

Therefore, out of a total of 1,616 level crossings those protected by some kind of crossing protection devices of two traffic subsystems, presented in Table 2 under numbers 2, 3, 4, 5 and 6, amount to 476 crossings, that is only 29.5% of the overall number of level crossings. This means that out of the total number of level crossings only 30% are protected by some kind of legally planned level crossing protection devices, and the remaining 70% are marked by St. Andrew's cross and adequate warning signals along the road warning the drivers that they are approaching a level crossing.

3. ANALYSIS OF TRAFFIC ACCIDENTS AT LEVEL CROSSINGS

In order to make maximally accurate estimate of the condition and traffic accidents at level crossings, let us consider the data over five i.e. six recent years.

Table 3 presents incident occurrences at level crossings in Croatia over the period of five years, from 1994 to 1998 and during the first nine months in the year 1999.

In Table 3, columns 2, 3, and 4 are of particular interest and they represent:

- column 2: the number of incident occurrences at all level crossings during the considered period,
- column 3: indicates the number of accidents caused by the railway,
- column 4: indicates the number of accidents caused by the third party, i.e. road traffic participants.

The data in these columns show that the railway was to blame in 5.7% and road traffic participants in 94.3% of the cases. These data show that there is an inevitable need for a serious and comprehensive analysis of such a great number of accidents caused by the road traffic participants. Only such an analysis can reliably determine the causes and find the ways for eliminating or at least reducing the number of accidents at level crossings.

Columns 6 and 7 are also important and they indicate:

- column 6: the number of persons killed in level crossing accidents during the observed period,
- column 7: the number of persons killed in other accidents involving railway in Croatia, during the observed period.

After only roughly analysing these two columns it may be observed that out of the total number of fatalities involving railway, almost 50% refer to level crossings (48.0% - column 6, and 52% - column 7). This indicates the entire seriousness of the problems regarding level crossings in the Republic of Croatia, and leads to the inevitable conclusion that this problem requires special attention so as to find real solutions that would eliminate or at least seriously reduce such a great number of accidents.

Similar situation is with injuries i.e. injured persons in traffic accidents presented in columns 9 and 10. Although the situation is somewhat more favourable here at level crossings in relation to the total number of serious injuries in accidents on the Croatian Railways (39.0% - column 9 - crossings, 61.0% - column 10 - others), it is still a reason for worry which deserves much greater care than the one it is receiving at the moment.

Column 8 represents data on suicides in which railway is used as place and method for committing this unfortunate act. However, this problem falls outside the context of these considerations and it certainly deserves special attention but within the frames of some other study.

Table 3 - Incident occurrences at railroad crossing in Croatia between 1994 and 9/99

Year	Number of incident occurrences	Fault of the railway	Careless behaviour of the third party	Protection method	Number of killed persons	Number of killed persons in other cases	Suicides	Number of seriously injured	Number of other injured persons	Number of damaged vehicles	Traffic standstill (h)	Material damage for the railway	Time period			damage on the railroad crossing (breaking of the ramp and half-barriers)
													0-6	0-18	18-24	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1994	36	2	34	A	13	42	27	17	49	23	17	119 598.00	1	27	8	
	56		56	B	8			24		51	35	721 043.00	5	37	14	
	5		5	C	1			2		2		5 436.00	1	3	1	411
1995	30	1	29	A	15	26	43	12	38	15	20	568 000.00	1	18	11	
	58		58	B	13			10		54	35	225 000.00	2	48	8	
	4		4	C	3						7			2	2	369
1996	32	1	31	A	11	19	37	4	33	13	13	177 000.00	4	19	9	
	54		54	B	6			12		48	41	793 000.00	4	40	10	
	1		1	C						1			1			329
1997	21	2	19	A	4	27	41	3	26	16	14	900 000.00	2	16	3	
	63		63	B	13			5		59	41	549 000.00	2	41	20	
	2		2	C						1	3	2 000.00	2			371
1998	35	1	34	A	14	22	47	11	26	21	23	804 000.00	3	24	8	
	42		42	B	13			10		36	25	415 000.00	4	28	10	
	1		1	C											1	327
Jan. - - Sept. 1999	22	3	19	A	13	6	34	5	15	22	36	374 000.00	1	17	4	
	24		24	B	5			5		24	9	267 000.00		19	5	
				C												272
Total	176	10	166	A	70			52		110	123	2 942 598.00	12	121	43	
	297		297	B	58			66		272	186	2 970 043.00	17	213	67	
	13		13	C	4			2		4	10	7 436.00	4	5	4	
Overall	486	10	476	A+B+C	132	142	229	120	187	386	319	5 920 077.00	33	339	114	2 079

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- A = railroad crossing – instrument-protected
 B = railroad crossing – visibility-protected
 C = pedestrian crossing – with cross-barriers

Column 12 – traffic standstill expressed in hours

Column 17 – damage, collision of road vehicles with closed or closing half-barriers and ramps without contact with railway vehicle, registered only as damage with exclusive fault of the third party

Column 12 represents the duration of a standstill in railway traffic due to accidents at level crossings, and column 13 the material damage caused by these accidents. These are also significant indicators showing the necessity of a serious involvement in these urgent and for the traffic very significant problems.

In this consideration another very important fact should be noticed, and it shows that relatively more accidents happen at the protected level crossings than at the unprotected ones. This can be seen in Figure 2. Here, it needs to be specially emphasised that protected level crossing means all those crossings that are fitted with any kind of device (light, barrier, half-barrier, audio signal, etc.), and unprotected crossings include all those crossings that are marked only by St. Andrew's Cross and road warning signs, which warn the road vehicles that they are approaching a level crossing.

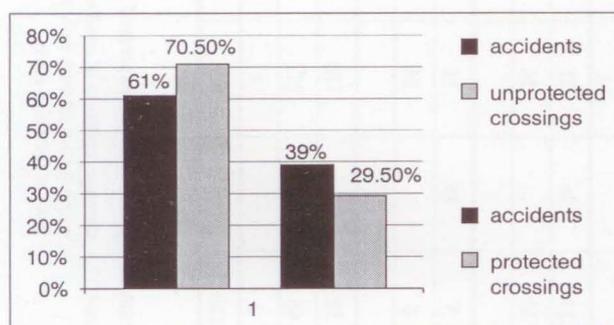


Figure 2

This fact, that relatively greater number of accidents occurs at protected level crossings than at the unprotected ones may be explained by the fact that traffic on the roads with protected crossings is much busier than on the unprotected ones. However, this is a much more complex and subtle problem, which requires also a far more detailed and serious analysis that will highlight a whole series of relevant facts and reasons that then lead to undesired events.

No doubt, the problems of traffic accidents at level crossings require serious engagement of a wide range of professionals and scientists, from the field of rail and road transport as well as from a wider field. Adequate and efficient solutions have to be found in order to overcome this urgent problem, by eliminating conflict situations between rail and road traffic that occur precisely at the place where these two most important surface traffic systems confront each other.

4. LEGAL PROVISIONS REGARDING SAFETY AT LEVEL CROSSINGS

Looking at columns 3 and 4 in Table 3, one can notice a significant fact that only in 2% of the cases the railway is to blame for the accidents at level crossings

and in 98% of cases the blame falls on third persons, i.e. road traffic participants.

This fact speaks a lot for itself. It highlights, namely, the notorious problem that the road traffic participants are to blame for the traffic accidents at level crossings.

Why is it so?

The answer is far from easy or simple, but rather a very complex one, so that a real answer is difficult to find.

Let us try and find the answer in legal provisions.

In the Road Traffic Safety Act, from a total of 335 articles only three, Articles 111, 112 and 113 refer to the defining of traffic at level crossings. Due to the significance of the considered problem, all the three articles are quoted here:

Article 111:

- 1) A motorist approaching a level crossing is obliged to adjust the movement of the vehicle so as to be able to stop in front of a closing gate at the crossing or in front of the devices signalling the approaching train, i.e. so that the vehicle can stop before the railway line.
- 2) Traffic participants crossing the level railway line have to do it with necessary care.

Article 112

Traffic participants have to stop in front of the level crossing if the traffic gate is closed, or if the gate has started to close, or if flashing and ringing signals are on, which warn that the gate is going to close, i.e. that there is a train approaching the level crossing.

Article 113

At a level crossing without a gate or other signalling equipment announcing the approaching train, the traffic participants have to stop and cross the railway line only when they have made sure that there are no trains or any other vehicles approaching along the line.

Out of the total of 107 Articles in the Railway Traffic Safety Act, 10 Articles deal with the problems of traffic at level crossings, and these are Articles Nos. 49, 50, 51, 52, 53, 54, 55, 56, 57, and 59. However, all that is important for the level crossing safety is given in Articles 49, 50 and 51 quoted here:

Article 49

Rail and motorway crossing, trunk rail and trunk road crossing, and rail and road crossing at the area of railway station between the entrance turnouts at the beginning of the railway station tracks cannot be at the same level.

The crossing of a railway line and a road cannot be at the same level according to the criteria of high density of rail and road traffic, or if local circumstances require that or for any other reasons regarding traffic safety.

The criteria of defining the crossing in Item 2 of this Article are determined by a regulation brought by the Minister of Maritime Affairs, Transport and Communications.

Stipulations contained in Item 1 of this Article regarding crossings at railway station area refer also to crossing point.

Article 50

Vehicles and other road traffic participants can cross the railway line only at the road crossing, and the pedestrians may cross the railway line at the pedestrian crossing as well.

Train, i.e. the railway vehicle has the right of way at the crossing with relation to the road vehicle or any other road traffic participant.

Article 51

Traffic safety at the level crossing is insured by equipment or stipulated visibility from the road i.e. pedestrian path toward the railway line.

The device for protecting the level crossing is the device for closing the road crossing (barriers or half-barriers) or devices emitting signals announcing the approaching train or railway vehicle.

The device for protecting the pedestrian crossing is a device for signalling announcing the approaching train or railway vehicle.

Devices from Items 2 and 3 of this Article have to meet special technical conditions and they have to be in accordance with the Act regulating road traffic safety.

Special technical conditions that have to be met by the devices from Items 2 and 3 of this Article are stipulated by a general Act brought by the public enterprise.

The devices for protection of the road and pedestrian crossings over the railway line, are set and maintained by the public enterprise, and on the industrial track by the company that owns it.

For the analysis of legal provisions regulating the safety of ground transport, it is necessary to state just some sections as well as the Act on Road Transportation.

Only some of the items of certain Articles need to be quoted here:

Article 4

Item 7 – A motorist is a person with the completed secondary education in the profession of a driver.

Moreover, the generally known fact is that the motorists wanting to drive a road motor vehicle, have to have passed the exams in legally stipulated categories: A, B, C, D, E, F, G, or H.

Taking into consideration all the laws and their significant articles here, it may be concluded that if these regulations at road-railway crossings were literally applied, there shouldn't be a single traffic accident.

However, this is not so. Even besides all the legal limitations and regulations, grave traffic accidents still occur at level crossings.

The most frequent reasons for traffic accidents at level crossings include carelessness or irresponsible behaviour of the road traffic participants.

5. CAUSES OF CARELESSNESS AND IRRESPONSIBLE BEHAVIOUR OF ROAD TRAFFIC PARTICIPANTS

As already mentioned, Table 3 indicates that in 98% of traffic accidents at road-rail crossings, the one to blame is a third person, i.e. the road traffic participant. However, the question is, how come these accidents happen, in spite of the precisely legally defined behaviour of both rail and road traffic participants, which almost as a rule end up in great material damage, and unfortunately very often with fatalities and seriously injured people, active and passive traffic participants.

Unfortunately, science has not yet answered this question, probably because this problem has still not received adequate attention, although on the average 30 fatalities a year would certainly require greater engagement.

However, the experience of professionals who have been directly or indirectly involved in this issue, shows that the most often cause of these accidents has been alcohol, irresponsible behaviour of the motorists and miscalculation.

Unfortunately, there have been no serious studies made up to now that would find the answer to the question regarding what percentage corresponds to individual cases mentioned above in the total number of accidents. The fact is, however, that these are the most frequent causes of all the unexpected events at level crossings.

A more detailed explanation of these three groups of causes is as follows:

1. In case of accidents caused by too much alcohol and drunken driving, this is the already well-known fact that these motorists have significantly reduced sense of responsibility and increased sense of irresponsible courage which borders with incompetence.
2. The case of irresponsible behaviour includes road vehicle motorists who are generally prone to traffic rules violation and while driving behave almost always on the edge of incidents, thinking that they have an infallible driver's instinct and above all fast reflexes, which, they believe, always pull them out intact even from the most critical traffic situations.
3. The case of miscalculation includes those motorists who are convinced that experience has taught

them that after the signal or the closed half-barrier have stopped the traffic at a level crossing, there is still some time that allows crossing without risk. Unfortunately, this "unwritten rule" may be true in case of slow trains which activate the crossing signalling devices on their approach. These crossings, however, have not been regulated for the fastest possible trains on these lines, so that in case of fast train approaching, such miscalculation from experience may prove fatal. Also, in case of a double track railway line, the motorist's false experience from a single track railway line makes the motorist think that there is no danger in crossing a closed railway line after one train has passed through. This happens even in spite of the warnings at such crossings stating "two trains" or double "St. Andrew's cross". If the motorist following such false experience or miscalculation decides to cross after the first train, there is high probability of colliding with the next train from the opposite direction.

Therefore, regarding all the mentioned circumstances and experience about traffic accidents with fatalities, no time should be wasted any more and science should really take this problem into serious consideration, exactly defining it and proposing adequate and satisfactory scientific solutions.

6. CONCLUSION

1. These considerations have been based on statistical data of the Interior Control Service of the Croatian Railways about traffic accidents at level crossings over the period of five, that is six years. However, this is not enough for objective recording of the state-of-the-art and for full objectivisation of all the causes and real reasons for the current condition of the level crossings in the Republic of Croatia.
2. An overview of the whole documentation regarding accidents at level crossings should be made, as well as on the current condition in rail and road traffic including objective future prospects. Wide and comprehensive analysis of all the available documents would allow objective comprehension of all the main causes of this very complex problem and the making of correct and definitive conclusions and suggestions.
3. It would be necessary first of all to analyse the existing acts and regulations that treat this problem and to determine possible dilemmas and contradictions whose possible existence makes the already conflicting situation even worse.
4. It is then necessary to analyse the level of knowledge, qualifications and psychophysical capabilities of road motorists, both professionals and amateurs.
5. With great care and objectivity, the legal penalty measures should be analysed, which should have preventively influence the reduction of traffic accidents at level crossings.
6. Primarily as prevention, technical controlling devices should be introduced as well as documented tests of the discipline shown by road traffic participants, and in railway traffic at all critical points, especially at level crossings as the hot spots of the land traffic.
7. Above all, modern technological solutions require introduction of a maximum number of safety and control elements that would guarantee substantially higher reliability, availability and safety in the technological rail and road traffic processes.
8. Proper methods as well as adequate mathematical models need to be defined, that would bring more order into this complex problem, as well as define obligations of how and which level crossings should be protected, and in which manner, or eliminated, and even consider the possibility of separating road and rail traffic into two levels.
9. Since this problem is neither of local nor narrow national character, it needs to be internationalised and solved in a wide international co-operation by engaging the necessary number of professionals, scientists and providing financial means in order to bring it as efficiently and as soon as possible to a reasonable level.

SAŽETAK

ANALIZA ČIMBENIKA SIGURNOSTI PROMETA NA ŽELJEZNIČKO-CESTOVNIM PRIJELAZIMA U RAZINI

U radu se analiziraju glavni čimbenici prometne sigurnosti i pouzdanosti na željezničko-cestovnim prijelazima u razini.

Konstatira se broj i uzroci nesreća koji su posljedica neznanja, nedovoljnog osposobljavanja učesnika u prometu, njihove neodgovornosti i nedovoljne ili nepotpune zakonske regulative, kao i nedovoljno stručnog i znanstvenog serioznog pristupa rješavanju tog kardinalnog problema u cestovnom i željezničkom prometu.

Na temelju analize utvrđuju se uzroci i predlažu rješenja, te efikasnije metode za poboljšavanje sigurnosti i smanjenja prometnih nesreća na cestovno željezničkim prijelazima u razini.

LITERATURE

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