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ANALYSIS OF CONFLICT SITUATIONS ON ROUNDABOUTS IN VALAŠSKÉ MEZIŘÍČÍ

ANALÝZA KONFLIKTNÍCH SITUACÍ NA OKRUŽNÍCH KŘIŽOVATKÁCH VE VALAŠSKÉM MEZIŘÍČÍ

Abstract

The article describes briefly the methodology of video analysis of conflict situations and presents the results of the video analysis performed on roundabouts in Valašské Meziříčí. This paper was prepared with financial support for research and development project No. CG911-008-910 "The influence of construction components on the safety and continuity of transport in roundabouts and possible prediction of traffic accident occurrences"

Keywords

Road Transport, Video analysis, Roundabout.

Abstrakt

Článek popisuje stručně metodiku videoanalýzy konfliktních situací a uvádí výsledky videoanalýz provedených na okružních křižovatkách ve Valašském Meziříčí. Příspěvek byl zpracován za finanční podpory projektu výzkumu a vývoje č. CG911-008-910 „Vliv geometrie stavebních prvků na bezpečnost a plynulost provozu na okružních křižovatkách a možnost predikce vzniku dopravních nehod“ Ministerstva dopravy ČR.

Klíčová slova

Silniční doprava, videoanalýza, okružní křižovatka.

1 INTRODUCTION

Safety of road transport is among pressing issues of the modern society. Traffic accidents, being a tragic consequence of the pace and comfort of the present-day life, is discussed at all levels. Unfortunately, in many cases dangerous locations in roads are dealt with only when it is too late and a grave accident happens. It is necessary to keep in mind that not only people (the injured or the survivors) are affected: economic damage should be considered as well (the price of a life of a person who dies in a road accident exceeds now 10 million CZK - some sources mention as many as 3 million USD).

Development of traffic accidents in the Czech Republic (Fig. 1) is based on the computer registry of road accidents kept by the Czech Police Administration [1]. As of 1 January 1979 every road accident reported to the Police are included into the statistics. As of 1 January 2001 the statistics includes only road accidents reported to the Czech Police but the difference is that a person involved in the accident is obliged to inform the Police about his/her accident only if the damage exceeds

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20,000 CZK or if a person is injured/dies or of third party's property is damaged. As of 1 July 2006 the damage limit to report an accident increased up to CZK 50,000. As of 1 January 2009 the limit went up to CZK 100,000[1]. This means, that the statistics data about road accidents are not much reliable for the individual years (see, for instance, a considerable decrease in the number of road accidents in 2009). It should be also pointed out that for purposes of statistic records each person who dies at the place of the accident, upon transfer to a hospital, or within 24 hours after the accident is regarded as a person who dies in connection with the accident.

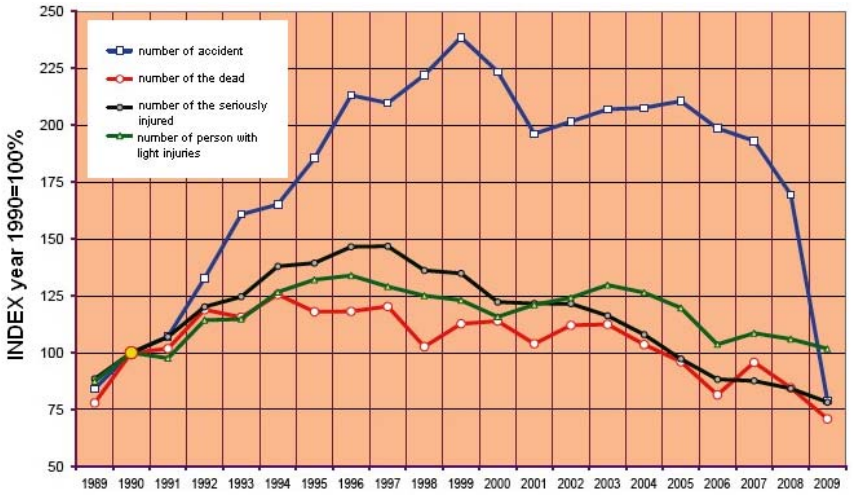

Fig.1: Development of traffic accidents in the Czech Republic, 1990 – 2009 [1]

If possible, transport accidents should be avoided. Sometimes, it is enough to eliminate small hidden factors which might, under certain conditions, be the factors affecting the road accidents. In other words: no traffic designer may with absolute certainty say that their solution is absolutely safe and reliable. It is the monitoring of road accidents which should provide the traffic designer with information about reliability. I have been dealing with the monitoring and assessment of behaviour of traffic users since 1998 and this paper presents certain results of my work.

2 METHODOLOGY USED IN VIDEO ANALYSES OF CONFLICT SITUATIONS

A conflict situation is any moment and situation in road traffic where any traffic user faces (or may face) a higher than usual degree of danger. Each traffic accident is preceded by a conflict situation. A traffic accident is, in fact, the consequence of the conflict situation when it was not possible to avoid risk of crash of a vehicle with its surroundings. This means, the conflict situations are potential accident situations.

Considering the limited scope of this paper, it is impossible to describe in detail all aspects of the video analysis of the conflict situation (this method is also referred to as the Folprecht's video analysis of conflict situations where Folprech is the author of this original method). Let us describe basic facts only. For more details see, for instance, [2] through [4].

The conflict situations visible in a one-hour video record are described with a three-character code which consists of a digit (describing parties involved in a conflict situation), a number (or numbers describing the conflict situation) and another digit (describing gravity of the conflict situation).

The first character in the three-character code is as follows:

- 1 ... pedestrian,
- 2 ... vehicle,
- 3 ... tram
- 4 ... pedestrian X vehicle
- 5 ... pedestrian X tram
- 6 ... vehicle X vehicle
- 7 ... vehicle X tram
- 8 ... tram X tram
- 9 ... other (cyclist, ...)

The second character may comprise one or more letters, as necessary, so that it could describe at best the conflict situation. Letters used for this code are being developed continuously and other letter can be included, if necessary, into the list below. Below are examples of the letters used in the code:

- D..... rear crash collision
- ch.... a pedestrian is to blame
- v.... a vehicle (its driver) is to blame
- c... a cyclist is to blame
- m.... a motorcycle (a motorcyclist) is to blame
- f_k ... because of a queue in a crossing
- f_p ... because of a queue in front of a pedestrian crossing
- n .... the way was not given
- g.... the way was given (but should not be given)
- z.... instructions were not followed: the stopping prohibited or waiting prohibited or incorrect stopping/waiting
- j... incorrect driving (in general)
- j_o ..incorrect driving– too close to a kerb

The third character describes gravity of a conflict:

- level 1 – this situation can be regarded as a potentially conflict situation. Traffic rules are violated by an isolated traffic user (without any other who could be jeopardised there).
- level 2 – in this situation, fluency of the traffic is affected. There are anomalies which do not result in a forced reaction, but certain hesitation, aggressiveness or just incorrect behaviour are evident and result in response of other road users
- level 3 – the situation when a collision can be avoided only by a prompt manoeuvring (sharp braking or sudden turning)
- In other cases, an accident will occur – the accident is often described as the level 4 gravity conflict.

Certain information about the degree of risk for a certain location is given by a relative conflict rate indicator - k_R – which describes the number of conflict situations (KS) per 100 vehicles or 100 pedestrians. k_R is calculated as follows:

$$k_R = \frac{P_{KS}}{I}.100 \ \left[KS/100\,voz\right] \tag{1}$$

where:

P_{KS} – number of conflict situations (KS) per hour [KS.h^{-1}],

I – hour traffic intensity [vehicles/h].

For the sake of clarity, the conflict situations are drawn in an intersection plan view – see examples in Fig. 2.

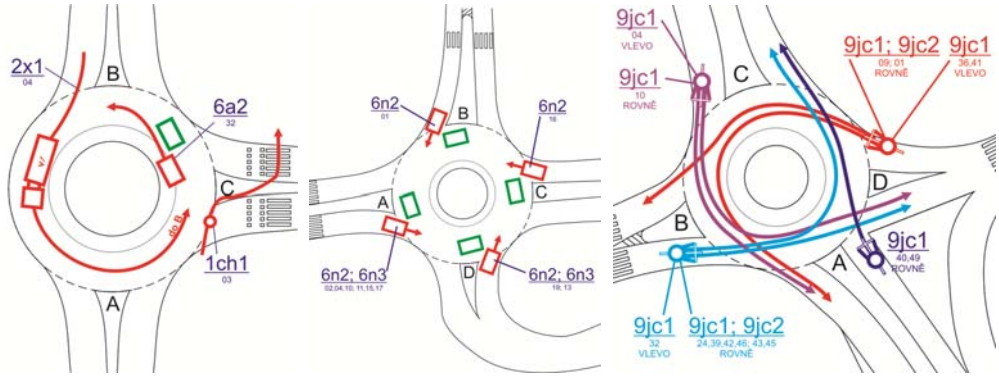

Fig. 2 Locations and development of conflict situations (examples, no scale) [5]

It is beyond doubts that the Folprecht's video analysis of conflict situations brings many benefits and is really useful. Thanks to the video analysis, any real transport situation can be moved from street rush to quiet office of a transport experts who can analyse it, re-play or play in slow sequences. This eliminates disturbing influence of road traffic (such as noise, dust, emissions, vibrations, traffic intensity...) or those of weather (such as a temperature, wind, or rain). The video record can be used for identification of other basic characteristics of the traffic in that location such as intensity and structure of traffic flows.

3 VIDEO ANALYSIS OF CONFLICT SITUATIONS IN CERTAIN ROUNDABOUTS IN VALAŠSKÉ MEZIŘÍČÍ

Following sections summarise results of the video analyses performed for certain roundabouts in Valašské Meziříčí. Because the extent of this paper is limited, only major conflict situations will be described and conclusions will be drawn. For more details see [5] through [8].

For video records of the conflict situations see records http://kds.vsb.cz/krivda/ok-vm *[9].*

3.1 Roundabout at the Masarykova street, next to TESCO hypermarket

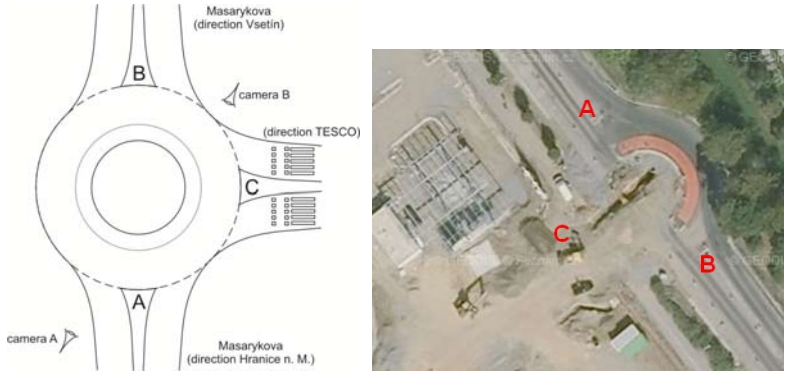

Fig. 3. Roundabout at the Masarykova street, next to TESCO hypermarket

The most frequent conflict situation in that roundabout was $2j_o1$ when a vehicle moving from the B leg straight on into the A leg was close to the kerb in the A exit on the right-hand guide line. The kerb was damaged there probably by vehicles which failed to keep the track in the circulation belt and move out of the road. This situation occurred 23 times during an hour (1.78 KS per 100 vehicles). In 14 cases (61 %), the vehicles were trailer trains, in 2 cases (9%) - semi-trailer trains, in 6 cases (26%) - trucks and in one case (4%) - a bus.

The reason for such conflict situation seems to be a relatively high speed of the vehicles who enter Valašské Meziříčí and see quiet a wide road in front of them (and this induces over-speeding). It is believed that the exit has been designed correctly (the capacity for the vehicles above can be verified simply by drag curves). This means, the drivers appeared to fail to drive the roundabout correctly. In order not to damage the kerb and in order to prevent road accidents, a solution would be to build a reinforced crescent-shape roadside at the A exit. Big vehicles could drive then safely on the roadside.

Fig. 4 Details of the damaged kerb at the A exit and a trailer train driving too close to the kerb

Another frequently-occurring conflict situation was $(6)f_k2$ when a queue of vehicles in the next roundabout (in a distance of 145 m) stopped the traffic at the B exit (5times per hour; 0.39 KS per 100 vehicles). The C entrance, C exit and A entrance were restricted as well (5, 2, 2, respectively). The queue caused the vehicle to delay for 32 seconds approximately (minimum: 15 s, maximum: 40 s). Such a situation occurred only five times during one hour. But in higher traffic intensity (such as on Friday afternoon when more people leave the town for weekend or go shopping to the TESCO hypermarket), such situations would be, in all probability, more frequent and more subsequent situations would have to be dealt with.

The total relative conflict rate indicator - k_R – includes also the $2j_o1$ conflict situations (in addition to direct and indirect conflict situations which are not related directly to the roundabout – see [4]). In that case, k_R = 2.41 KS /100 vehicles . Table 1 lists the frequency of direct and indirect conflict situations and relative conflict rate indicators.

Table 1: Relative conflict rate indicator, k_R (I = 1,290 vehicles/hour)

Conflict situation	P_{KS} [KS/h]	k_R [KS/100 vehicles]
2j$_o$1	23	1.78
Indirect KS	7	0.55
Direct KS	1	0.08
TOTAL	**7**	**2.41**

3.2 Roundabout between the Hulince – Masarykova – Hřbitovní streets

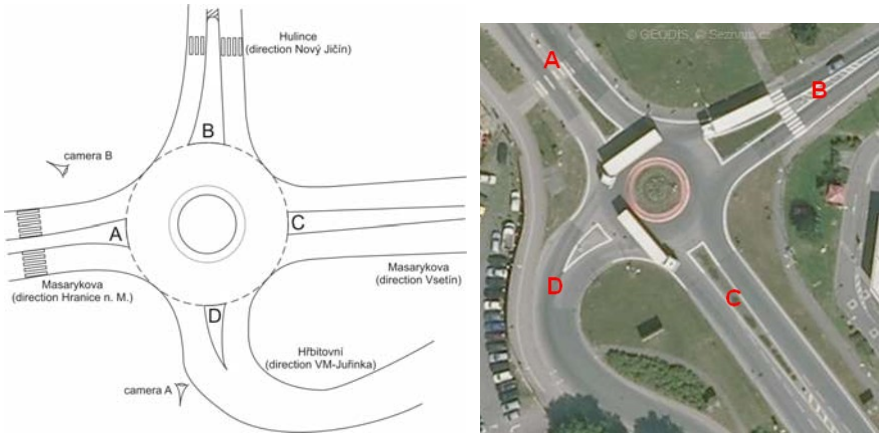

Fig. 5: Roundabout between the Hulince – Masarykova – Hřbitovní streets

The most severe problem in this roundabout is not giving the way, this means **6n2** (6 KS/h, that is 0.36 KS/100 vehicles) and **6n3** (4 KS/h, that is 0.24 KS/100 vehicles). Such situations are not, however, too frequent. What is important is that 40% of such conflict situations had the gravity of 3. This means that only sharp braking or sudden evasive manoeuvring would prevent the vehicle(s) from crashing. The most frequent conflict situation is „n“ in the A entrance (a half of occurrences). In two cases, such conflict situations resulted in a “g” conflict situation.

Another problem occurred in two cases when a trailer train had to stop in a place where another vehicle (**6z2,** indirect KS) was waiting, with its some of its wheels on a pavement (behind the D exit, in the Hřbitovní street, in front to the entrance). It was not possible to overtake the vehicle because other vehicles were moving in the opposite direction. This might have been a special situation but suitable traffic signs (stopping prohibited or waiting prohibited) might, theoretically, prevent such situations from occurring.

Pedestrians crossings posed no problem because few pedestrians only were walking there. It should be mentioned that out of the roundabout from the A leg to the D leg (and in the opposite direction) there is a joint path for pedestrian and cyclists. During the measurements, only one cyclist did not use the path and only one cyclist entered the path close to the roundabout (while the entrance to the path is located several meters in from of this - the entrance is not, however, marked well with traffic signs).

The total relative conflict rate indicator - k_R – includes only the direct and indirect conflict situations (no conflict situations for which this indicator is identified were relevant enough to be included into the total indicator). The total relative conflict rate indicator - k_R - is 0.90 conflict

situations per 100 vehicles. Table 2 lists the frequency of direct and indirect conflict situations and relative conflict rate indicators.

Table 2: relative conflict rate indicator, k_R (for I = 1,648 vehicles/hour)

Conflict situation	P_{KS} [KS/h]	k_R [KS/100 vehicles]
Indirect KS	2	0.12
Direct KS	13	0.78
Total	**15**	**0.90**

3.3 Roundabout between the Rožnovská – Masarykova – Nádražní streets

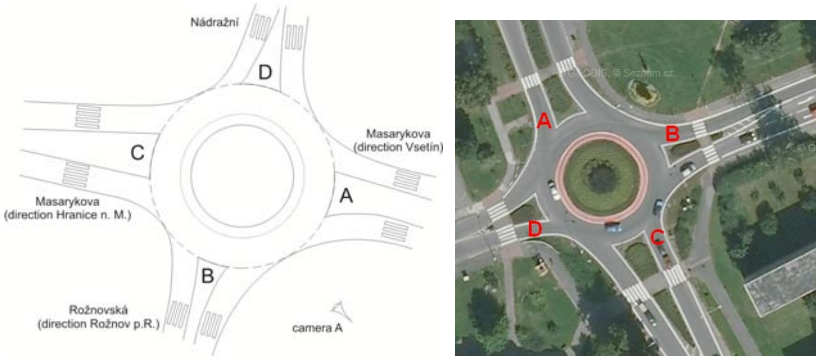

Fig. 6: Roundabout between the Rožnovská – Masarykova – Nádražní streets

The most severe problem in this roundabout is against not giving the way, this means **6n2,** or **9nv2** and **9nr2** (14 KS/h, this means 0.65 KS/100 vehicles) and **6n3** (3 KS/h, this means 0.14 KS/100 vehicles). Such situations were rather frequent: 17.6% of such conflict situations had the gravity of 3. This means that only sharp braking or sudden evasive manoeuvring would prevent the vehicle(s) from crashing. The most frequent conflict situation is „n“ in the A entrance 52.9%).

In this roundabout, vehicles again stopped in front of the pedestrian crossing (4 times in the D leg and once in the B leg) and hit the circulation belt or the preceding entrance - **(4)f$_p$2**. This conflict situation occurred most in the D leg where rather many pedestrians crossed the street and the pedestrian crossing is located about 10 m from the outer diameter of the roundabout. In the B leg, the pedestrian crossing is located about 12 m from the outer diameter. In both cases, the space between the circulation belt and the pedestrian crossing is long enough for two standard cars (including the gap between them) to stop. In spite of the fact that such conflict situations are not too frequent, it should be considered whether it would be a better solution to move the pedestrian crossing further from the circulation belt (taking into account the fact that the pedestrians might be then less willing to walk more to reach the pedestrian crossing). It is not recommended to cancel the D leg pedestrian crossing because this pedestrian crossing is used quite often.

The video record, however, does not show one of most pressing issues the local drivers (incl. the author who took and analysed measurements) are aware of and which was witnessed during taking the video records. In almost all roundabout legs, long queues appear in the entrances and vehicles have to wait (this may result in conflict situations such as rear crash during inching in a queue or during zipping in the A entrance where two lanes merge to create an only one). It would be recommended to evaluate the capacity of this roundabout and, if necessary, to propose changes in the traffic and organisation (to change the shape of the roundabout or control the traffic by means of lights in peaks).

The total relative conflict rate indicator - k_R – includes only the direct and indirect conflict situations (no conflict situations for which this indicator is identified were relevant enough to be included into the total indicator). The total relative conflict rate indicator - k_R - is 1.16 conflict situations per 100 vehicles. Table 3 lists the frequency of direct and indirect conflict situations and relative conflict rate indicators.

Table 3: relative conflict rate indicator, k_R (for I = 2,141 vehicles/hour)

Conflict situation	P_{KS} [KS/h]	k_R [KS/100 vehicles]
Indirect KS	0	0.00
Direct KS	25	1.16
Total	**25**	**1.16**

3.4 Roundabout between the Zašovská – Masarykova – Vsetínská – Křižná streets

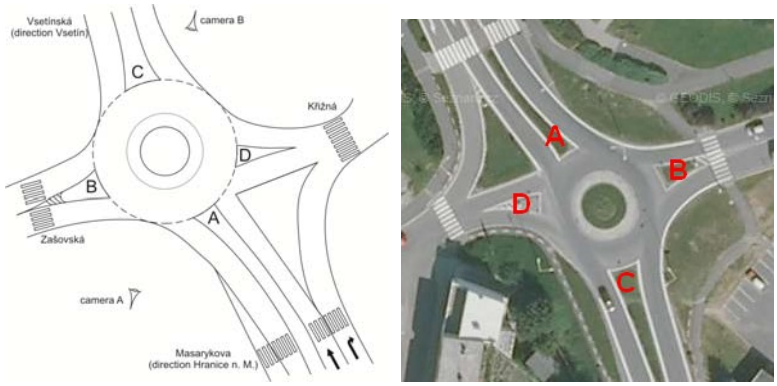

Fig. 7 Roundabout between the Zašovská – Masarykova – Vsetínská – Křižná streets

The most severe problem in this roundabout is again not giving the way, this means **6n2** (13 KS/h, that is 0.367 KS/100 vehicles) and **6n3** or **9cv3** (3 KS/h, that is 0.15 KS/100 vehicles). Such situations were really frequent: 18.8% of such conflict situations had the gravity of 3. This means that only sharp braking or sudden evasive manoeuvring would prevent the vehicle(s) from crashing. The most frequent conflict situation is „n“ in the B entrance (50.0%).

Another issue in this roundabout is the vehicles that stopped in front of the pedestrian crossing (10 times in the A leg and twice in the B leg) and hit the circulation belt or the preceding entrance – **(4)f_p2**. This conflict situation occurred most in the D leg where rather many pedestrians crossed the street and the pedestrian crossing is located about 28 m from the outer diameter of the roundabout. This distance is long enough for 4-5 cars to stop there (incl. the gap between them). It follows from the video records that buses and trucks stopped there often and because many pedestrians use the pedestrian crossing, such conflict situations were not rare. It is not recommended to cancel this pedestrian crossing because this pedestrian crossing is used quite often.

In the B leg, the pedestrian crossing is located about 12 m from the outer diameter. In this case, the space between the circulation belt and the pedestrian crossing is long enough for two standard cars (including the gap between them) to stop. In spite of the fact that such conflict situations are not too frequent, it should be considered whether it would be a better solution to move the zebra further from the circulation belt (taking into account the fact that the pedestrians might be then less willing to walk more to reach the zebra).

It is interesting that the (4)f_p2 conflict situations occurred in the roundabout only in the first 20 minutes of the records (9 occurrences) and in the last 7 minutes (3 occurrences). It is believed that the reason is arrival of rather loaded buses to the near-by bus terminal in those times.

The conflict situation (4)f_p2 resulted in two subsequent situations **6D3** when a vehicle driving on the circulation belt almost crashed into another vehicle which stopped in front of the pedestrian crossing at the B exit. It was only a sudden braking which prevented the crash.

Conflict situations **9jc1** (12x/h, 0.62 KS/100 vehicles) and **9jc2** (3x/h, 0.15 KS/100 vehicles) are rather frequent: a cyclist did not ride the right-hand edge of the circulation belt but the centre or edge of the ring. In most cases, no other traffic users were affected but it might be a good solution to consider introduction of special lanes of cyclists at the outer perimeter of the circulation belt.

The total relative conflict rate indicator - k_R – includes only the direct and indirect conflict situations : k_R = 2.40/100 vehicles. Table 4 lists the frequency of direct and indirect conflict situations and relative conflict rate indicators.

Table 4: relative conflict rate indicator, k_R (for I = 1,942 vehicles/hour)

Conflict situation	***P_{KS} [KS/h]***	***k_R [KS/100 vehicles]***
Indirect KS	0	0,00
Direct KS	45	2,30
Total	**45**	**2,30**

Because **9jc1** is very frequent and has got a serious gravity, this type of conflict situation should be included into the total conflict situation rate indicator. Then, k_R is **2,92** conflict situations per 100 vehicles.

4 CONCLUSION

Each problematic place on the road, whether it is a roundabout or a pedestrian crossing, a road section or railway crossing, should be analysed and checked for hidden factors that cannot be revealed in the project or analysis of traffic accident rates. It is highly recommended to monitor conflict situations in new facilities where the traffic accident rates have not been analysed so far. It is the Folprecht's video analysis of conflict situations which could increase traffic safety on the roads.

The results of the video analyses and other measurements will be used, among others, for the analysis of the influence of the geometry of building elements in roundabouts on the traffic accident rate which is investigated into within the project below.

ACKNOWLEDGEMENT

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