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INTERACTION OF ROUNDABOUT AND INTERSECTION WITH TRAFFIC LIGHTS WITH USE OF VIDEO ANALYSIS OF CONFLICT SITUATIONS

INTERAKCE OKRUŽNÍ KŘIŽOVATKY A KŘIŽOVATKY SE SVĚTELNÝM SIGNALIZAČNÍM ZAŘÍZENÍM S VYUŽITÍM VIDEOANALÝZY KONFLIKTNÍCH SITUACÍ

Abstract

The paper deals with problem of interaction of two nearby intersections (roundabout and signalized). The paper presents results of video analysis of conflict situations and design of modification with use of simulation in PTV VISSIM. This paper was prepared with financial support for research and development project No. CG911-008-910 "Influence of structural elements geometry on safety and fluency of operation on roundabouts and possibility of rise crashes prediction", the Ministry of Transport.

Abstrakt

Článek se zabývá problematikou vzájemného ovlivňování dvou blízkých křižovatek (okružní a světelně řízené). Jsou zde prezentovány výsledky videoanalýzy konfliktních situací a návrh na možnou úpravu S využitím simulace V PTV VISSIM. 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.

1 INTRODUCTION

At present, we can see correctly designed and capacitively proven intersections with various problems which are caused by various external influences. The roundabout on Prokeš's square in Ostrava-City (streets Sokolská and 30. dubna) is specific example – see Fig. 1. This intersection is influenced by near intersection with traffic lights (streets Sokolská and Českobratrská) in rush hours.

For analysis of problem on this intersection we can use video analysis of conflict situations. Conflict situation is a moment or a situation in road traffic when participants of road traffic are or can be endangered by other participants. The conflict situation predates every traffic accident. Every conflict situation is described by the symbol which includes description of participants of conflict situation, source of conflict situation and seriousness of conflict situation [1] – [4].

The usage of video-recording is very substantial and advantageous. It can be analyzed collectively and repeatedly. Disturbing influences of the road traffic (e.g. noise, dust etc.) and weather (e.g. temperature, wind, rain, etc.) are eliminated.

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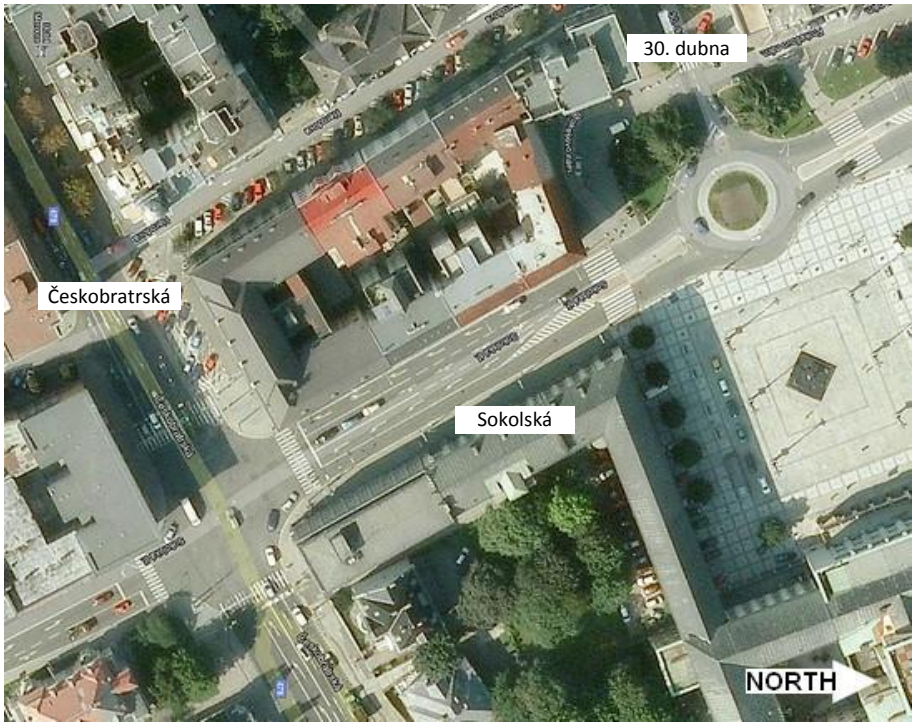

Fig. 1 Roundabout Sokolská/30. dubna and intersection Sokolská/Českobratrská in Ostrava-City [www.google.com].

2 VIDEO ANALYSIS OF CONFLICT SITUATIONS

Every conflict situation is described by the symbol which includes three parts [1] – [4]:

- one number – description of participants of conflict situation, e.g. 1 = pedestrian, 2 = car, 4 = pedestrian and car, 6 = two or more cars, 9 = other (one cyclist, cyclist and car etc.),
- one or more letters – description of source of conflict situation, e.g. f_k = influence of near intersection, f_p = influence of pedestrian crossing, n = violation of rule "yield to ...", a = aggression, g = giving priority against rule etc.,
- one number – description of seriousness of conflict situation:
    - the 1st level – potential conflict situations,
    - the 2nd level – conflict situations when one or more participants are restricted,
    - the 3rd level – conflict situations when one or more participants are endangered,
    - the 4th level – traffic accident.

We also distinguish several kinds of conflict situations [2], [4]:

- *own* conflict situation – a conflict situation which is related to traffic on the roundabout, its construction etc.; and *non-own* conflict situation – a conflict situation which is influenced by other conflict situation in the vicinity (for example, on other intersection),
- *primary* conflict situation – a conflict situation which isn't caused by other conflict situation; and *secondary* conflict situation – a conflict situation which is caused by other conflict situation.

The roundabout on Prokeš's square was monitored in June 2010. The most important conflict situation on this roundabout was situation described as $6f_k2$ (stopping or decelerating of traffic on circulating roadway due to queue of vehicles on other near intersection with traffic lights) – see

Fig. 1. Distance between intersections is 140 m. This situation occurred ten times per hour and it is a non-own conflict situation. The situation of this type can caused other (secondary) conflict situation (or traffic accident), e.g. rear-end collision in the queue of slowly moving vehicles.

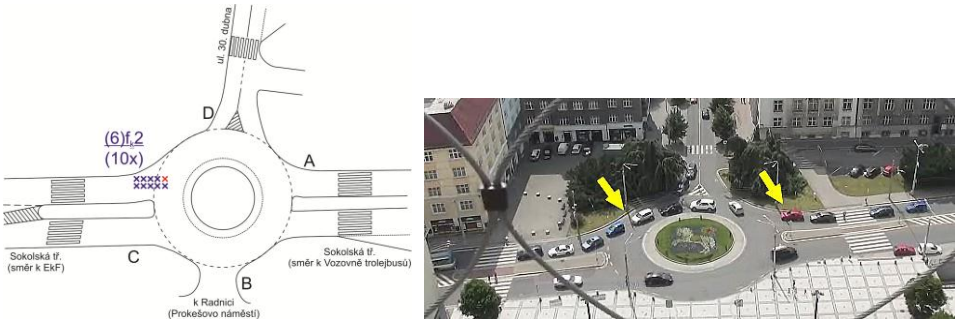

Fig. 2 Conflict situation $6f_k2$ [author].

To demonstrate, how this situation influences traffic on both intersections (roundabout and controlled intersection), we can use a special simulation software. Modeling and simulation are main tools in many areas of human activities. It can allow increase effectively of processes and activities in designing, development and not only in engineering and technology areas, also in service, economic and also transport areas [5]. The Department of Transport Constructions (Faculty of Civil Engineering) uses PTV VISION Software. This software is for transportation planning, strategic planning, transportation engineering and control. We use it partly by academics and partly by students during compiling their theses (i.e. not only by students of Faculty of Civil Engineering, but also by students of transport fields on Faculty of Mechanical Engineering).

Fig. 3 shows the model which was created by data of video analysis (volume and structure of traffic flows, conflict situations etc.). Presence and number of conflict situation $6f_k2$ was confirmed.

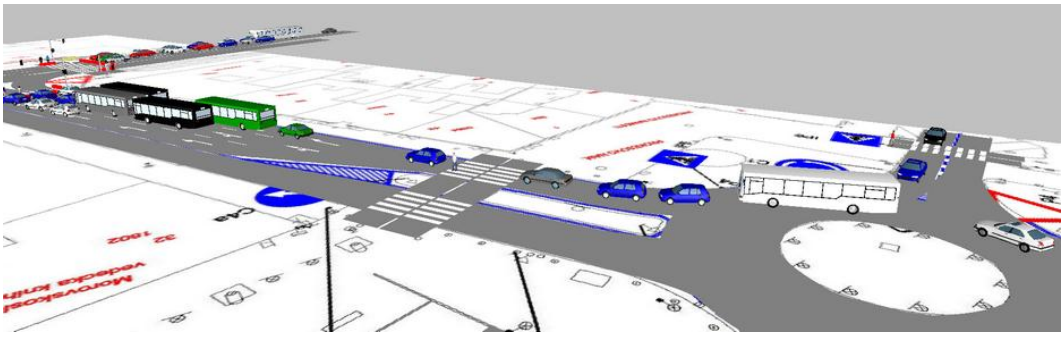

Fig. 3 Simulation of conflict situation $6f_k2$ (PTV VISSIM) [author].

Next frequent conflict situation was situation 6řa2 – see Fig. 4. Vehicles go round from the right other vehicles which are standing in queue between pedestrian crossing and circulating roadway (there is only one lane). The reason is that the vehicles choose getting lane which however is starting behind pedestrian crossing. This situation occurred 18 times per hour and it is also a non-own conflict situation.

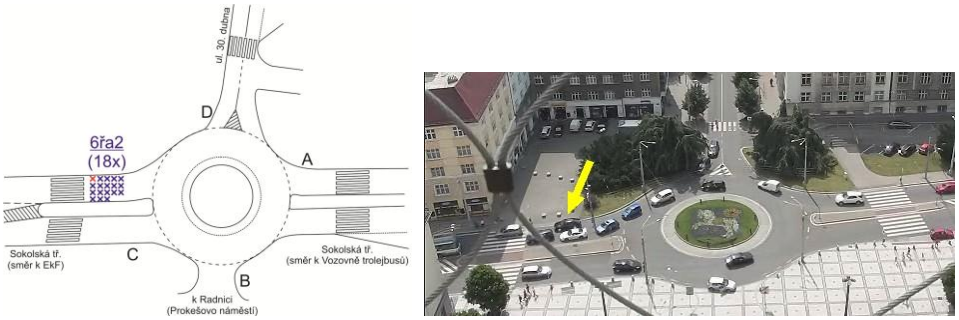

Fig. 4 Conflict situation 6řa2 [author].

Simulation in PTV VISSIM showed that roundabout also influenced traffic on controlled intersection. The queue before circulating roadway or before pedestrian crossing (leg C – marking according to Fig. 4) extended to controlled intersection – see Fig. 5. It was verified by own observation.

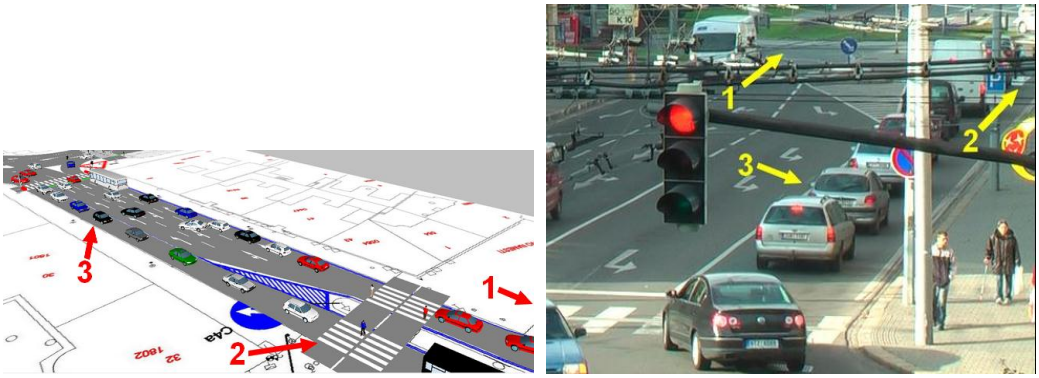

Fig. 5 Queue of vehicles between roundabout and controlled intersection
(1 – roundabout, 2 – pedestrian crossing, 3 – queue of vehicles between intersections) [author]

The other conflict situations on roundabout weren't connected with traffic on controlled intersection – for example (see Fig. 6):

- Stopping or decelerating of traffic on circulating roadway due to queue of vehicles before pedestrian crossing – conflict situation marked as $4f_p2$
- wrong ride of cyclist on circulating roadway – 9jc1 or 9jc2 (c = cyclist)
- aggression – 6a2, 9ar3 (r = motorcycle)
- violation of rule "yield to ..." – 6n2 or 6n3
- giving priority against rule – 6g2
- etc.

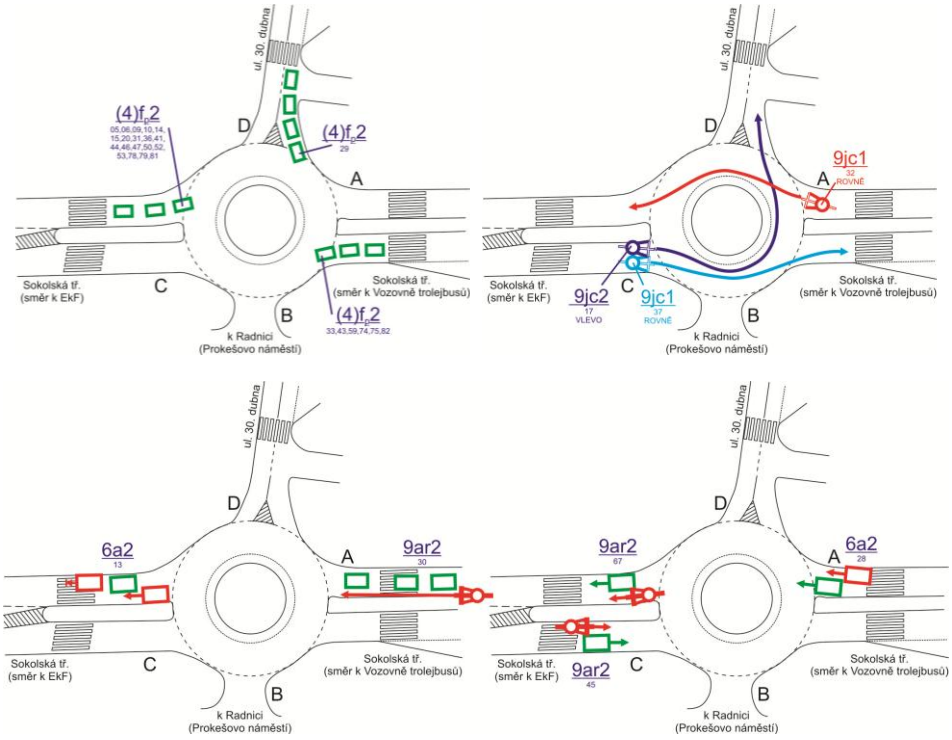

Fig. 6 The other conflict situations on monitored roundabout [author].

4 CONCLUSIONS

Video analysis of conflict situations on monitored roundabout showed that this type of intersection isn't appropriate to build near other intersection especially intersection with traffic lights. Similar problems was observed also between two near roundabouts (e.g. in Valašské Meziříčí, Nový Jičín, Havířov etc. – see [6], [7] or [8].

The most important conflict situation on roundabout on Prokeš's square in Ostrava-City is situation $6f_k2$ – stopping or decelerating of traffic on circulating roadway due to queue of vehicles on other near intersection with traffic lights. The solution of this situation can be reconstruction of this roundabout to conventional intersection with traffic lights and appropriate traffic signal coordination of both intersections. The other and cheaper alternative is for example installation of traffic lights on roundabout which can be use only during rush hours.

This paper was prepared with financial support for research and development project No. CG911-008-910 "Influence of structural elements geometry on safety and fluency of operation on roundabouts and possibility of rise crashes prediction", the Ministry of Transport [8].

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