



Use of alternative types of roundabouts in Mostar city for urban sustainability

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Abstract: The aim of the paper is to justify the construction of alternative roundabouts in the city of Mostar for the purpose of urban sustainability and by satisfying criteria. Namely, in urban environments, due to the limited space available, it is often necessary to investigate the possibility of applying non-standard solutions that can satisfy all the necessary criteria. Alternative types of roundabouts in the reconstruction of Kralja Tvrtka Street in the Mostar city are presented.

Key words: alternative types, roundabouts, urban sustainability, performance criteria

Primjena alternativnih kružnih raskrižja u gradu Mostaru u svrhu urbane održivosti

Sažetak: Cilj rada je iznijeti opravdanost izvedbe alternativnih kružnih raskrižja u gradu Mostaru u svrhu urbane održivosti, a prema zadovoljavajućim kriterijima. Naime, u urbanim sredinama, zbog ograničenosti raspoloživog prostora, često je nužno istraživati mogućnost primjene nestandardnih rješenja, koja mogu zadovoljiti sve neophodne kriterije. Predstavljena su alternativna rješenja kružnih raskrižja pri rekonstrukciji ulice Kralja Tvrtka u gradu Mostaru.

Ključne riječi : alternativni tipovi, kružna raskrižja, urbana održivost, kriteriji izvedbe



1. INTRODUCTION

When selecting a design solution for an intersection at a particular location, it is necessary to develop a feasibility analysis for implementation of the selected solution, for example by multi-criteria analysis using key criteria.

In this case, the key criterion is space. Spatial options allowed only small urban "quasi" roundabouts to be applied but in a way that meets all other key criteria during planning and design.

This paper presents justification for construction of alternative roundabouts, the so-called small urban "quasi" roundabouts, in Kralja Tvrtka Street on the locations R1 (intersection of Kralja Tvrtka and Stjepana Radića streets) and R2 (intersection of Kralja Tvrtka and Kralja Zvonimira streets), which for the intersections provide an improvement in efficiency measures as a key result, and in accordance with urban environment conditions. Namely, the key emphasis in an urban environment is placed on sustainability, which in terms of traffic means increasing positive measures (increasing capacity, increasing safety, ...) while reducing negative measures of intersections (reducing environmental impact, fuel consumption, reducing waiting time, ...).

2. DESCRIPTION OF THE SUBJECT LOCATIONS

The subject intersections R1 and R2 are situated in Kralja Tvrtka Street in the city of Mostar, and according to the position shown in Figure 1.

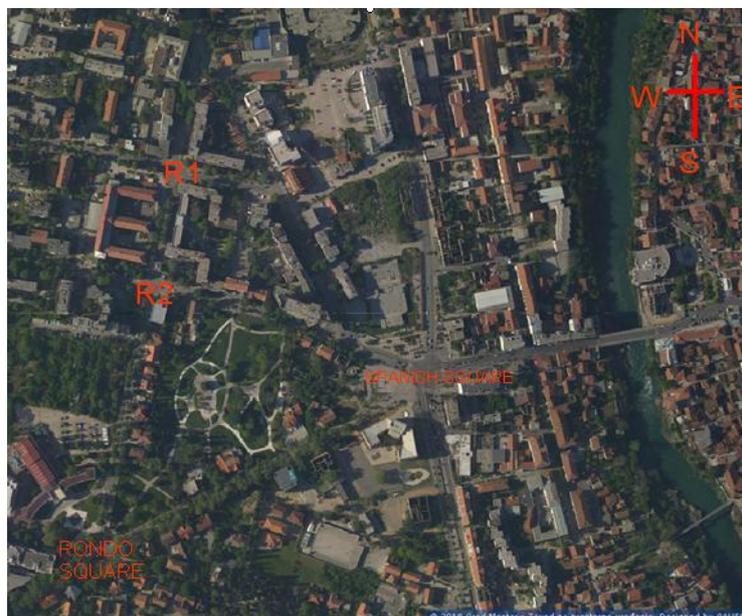


Figure 1. Spatial position of the subject locations in Mostar

An unsignalized intersection with characteristics of a very unsafe intersection and poor traffic functionality existed at the intersection of Kralja Tvrtka and Stjepana Radića streets until 2013. As a result of the study for the wider subject area developed within construction of Mepas Mall by the Faculty of Civil Engineering University of Mostar, an assembly roundabout of smaller dimensions was proposed as an efficient temporary solution.



Namely, introduction of traffic lights at this site was unacceptable due to the lack of space for construction of left-turn bays, and construction of a conventional type of one-lane roundabout was also unacceptable due to the lack of space.

The Faculty of Civil Engineering University of Mostar developed the design of the first assembly roundabout in Bosnia and Herzegovina at the subject location (R1). The assembly roundabout made of plastic New Jersey barriers in April 2013 improved traffic safety and capacity, and proved to be very efficient as a temporary solution (Figure 2).



Figure 2. Type of assembly roundabout at location R1

The disadvantages of this solution were the behavior of drivers at the beginning and maintenance of the assembly roundabout throughout the time. Since this was the first time for most drivers to encounter this type of intersection, they initially unfavorably received the aesthetic appearance of the assembly roundabout. Due to its excellent functionality, drivers accepted it well over time. An example of a better solution compared to the plastic New Jersey barriers was subsequently applied at the roundabout in Rodoč (Figure 3).



Figure 3. Type of assembly roundabout in Rodoč



At location R2 south of R1, there was a signalized intersection until September 2017, However, it was without left-turn bays in the main direction north-south, which resulted in long delays and poor level of service at these intersection approaches. With the reconstruction of R1 into an assembly roundabout, this signalized intersection was also found to be between two roundabouts, which is unacceptable in terms of traffic criteria because of interactions.

3. ANALYZED CRITERIA

According to the neighboring countries Slovenia and the Republic of Croatia, where traffic conditions similar to those in Bosnia and Herzegovina prevail, the key roundabout design feasibility criteria are: functional criterion, spatial criterion, project technical criterion, capacity criterion, traffic safety criterion, environmental criterion and economic criterion.

In contrast, the Guidelines for design, construction, maintenance and supervision on BiH roads do not cover all these criteria, or generally the use of alternative types of roundabouts that are applied in neighboring countries. Therefore, it is necessary to update the Guidelines with these types, but also to correct the present contents of the Guidelines. Alternative types include mini roundabouts, turbo roundabouts, flower-type roundabouts, and other non-standard solutions.

On the subject locations, in both cases the best solution is a small urban roundabout, called "quasi" because of its non-standard dimensions.

Specifically, in terms of these criteria, it provides the best level of service, minimum waiting, minimum queue length, minimum fuel consumption and minimum environmental pollution. It is also the safest solution for traffic participants, and in terms of the spatial criterion it is also satisfactory because it fits into space with its non-standard dimensions.

In terms of environmental protection, it should be emphasized that roundabouts represent an important element when selecting intersection type in urban environments, because it has been shown that vehicles release significantly less exhaust fumes and have reduced fuel consumption at roundabouts, all depending on improved capacity and less waiting as compared to unsignalized and signalized intersections.

4. DESCRIPTION OF SELECTED SOLUTIONS

So, construction of two "quasi" roundabouts started in September 2017 as part of the reconstruction of Kralja Tvrtka Street in Mostar, at intersections with Stepana Radića Street and Kralja Zvonimira Street. The designs of the roundabouts were developed by the Faculty of Civil Engineering University of Mostar in 2015, using experiences of their counterparts from the neighboring countries.

Application of conventional single-lane roundabouts was not possible at these locations primarily because of space as a limiting factor.

When developing the main design for the permanent roundabout solution at this location (R1), account was primarily taken of available space considering the positive experiences in operation of the assembly roundabout with outer radius $R_v = 10\text{m}$.

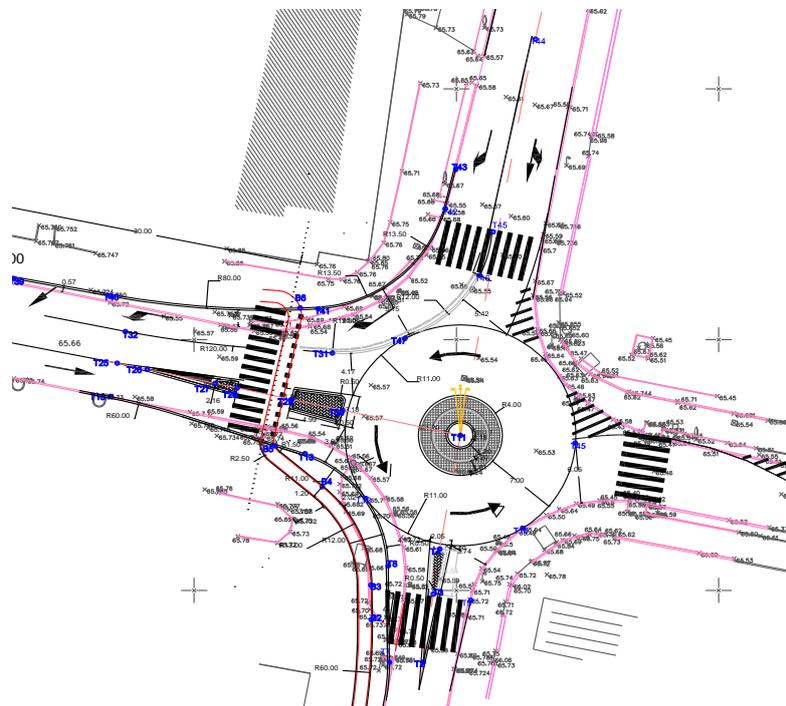


Figure 4. The main design of the "quasi" roundabout R1, 2015

The newly designed solution is an urban small one-lane "quasi" roundabout with a right-turn bypass from the north, in Kralja Tvrtka Street. The bypass was opened in order to improve the capacity because of the proximity of the adjacent intersection and easy accumulation of vehicles from the north direction in Kralja Tvrtka Street. A physical barrier made of Klemmfix concrete flush curbs is designed, but with a 5cm joint, to allow water to flow to appropriate gullies. The term "quasi" is attributed to these projects because of the non-standard dimensions applied due to space limitations.

The adopted design elements are $R_v = 11\text{m}$, $R_u = 4\text{m}$, or a circular lane 7 m in width, which ensures free movement for a bus, $l = 12\text{m}$, as the reference vehicle. The city's public transit lines do not run through the considered intersection, but bus is nevertheless assumed as the reference vehicle.

The reconstruction of the intersection R1 at the crossing of Kralja Tvrtka Street and Stjepana Radića Street into a roundabout automatically involves reconstruction of the intersection at the crossing of Kralja Tvrtka Street and Kralja Zvonimira Street R2 because a signalized intersection between two roundabouts is not preferable in terms of capacity. The problem associated with these two intersections is the small distance, or the proximity of the intersections.

The adopted design elements are $R_v = 12\text{m}$, $R_u = 5\text{m}$, or a circular lane 7 m in width, which ensures unhindered movement for a bus, $l = 12\text{m}$, as the reference vehicle. A regular line passes through this intersection in the west-east direction, and buses run through the roundabout not using the traversable part of the central island.

For both these roundabouts, a central island of granite cubes 10x10 laid in 10cm concrete is planned, with road LED lighting with four inclined poles and four luminaires in the center. Green belt in a 1.2 m circle edged with road curbs 18x24 cm is designed around the lighting. Passage of heavy goods vehicles larger than buses is thereby ensured using the



traversable part of the central island, all because of the fact that there is still no prohibition for heavy goods vehicles through the city of Mostar.

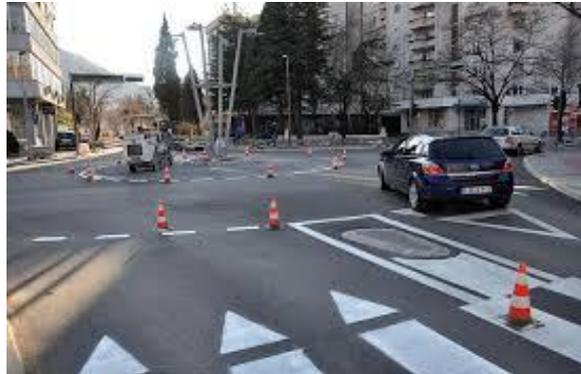


Figure 5. "Quasi" roundabout at location R2

5. CONCLUSION

Analysis of key criteria for justifying construction of a certain type of intersection is an essential and very important stage before design. Further, there is a need for implementing new design ideas to reduce the negative impact of traffic in cities for the purpose of traffic sustainability, and especially in terms of capacity, safety and environmental protection. For all these reasons, it is necessary to update the Guidelines.

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