Methods of Modeling the Bicycle Traffic Flows on the Roundabouts

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Abstract. The paper deals with the bicycle traffic issues on the roundabouts and their nearby areas. The fundamental elements of traffic management and infrastructure used in traffic regulation on the roundabouts have been presented. The authors present also the examples of typical settings of the bicycle paths. Amongst the conventional solutions some interesting ones from abroad, from the Netherlands in particular, which grant a huge level of traffic safety while crossing a roundabout, have also been introduced.

Keywords: bicycle traffic, bicycle path, roundabout, traffic safety.

1 Introduction

For many reasons the modern roundabouts are being considered much safer than other types of the road intersections. The main effect on the safety of such junctions is due to a low velocity of the vehicles passing through as well as much lower number of the points of collision if comparing these to the other types of intersections. On the two-lane roundabouts, as on the contrary to the one-lane roundabouts, one will notice that there are some additional points of collision when changing lanes on the roundabout envelopes as well as when exiting the flow and the roundabout envelope. This lowers the road safety of the cyclists on such type of the roundabouts in comparison to the one-lane roundabouts.

There are different ways of improving the safety quality of the cyclists in the intersection areas. This concerns both the infrastructural solutions and the traffic management on the intersections. The fundamental elements of traffic management and infrastructure used in traffic regulation on the roundabouts have been presented below.

2 Methods of Routing Bicycle Paths on Roundabouts

As in case of other types of intersections it is possible to run the cycle traffic on the roundabouts in many different ways. The number of points of collision between the vehicles and cyclists on a roundabout depends on a location of a bicycle path or lack thereof. Hereafter some typical solutions applied to Poland and those one may find only abroad are being presented.

J. Mikulski (Ed.): TST 2010, CCIS 104, pp. 115–124, 2010.

2.1 Non- sectioned Cycle Paths on Roundabouts

Non- sectioned bicycle paths on roundabouts are the most common solution. The cyclists and the drivers on the roundabouts are treated equally. In case when there are non- sectioned bicycle paths the cyclists need to use the same lanes as the drivers. Therefore, all traffic rules apply to them as much as to the other road users. The cyclists are considered as vehicles and let be ridden around the roundabout the same way like the drivers would have to do. Thus the vehicle and bicycle flows are mixed together, which creates some dangerous situations on the road (Fig. 1a, 1b). As it has been mentioned in some works [2], [3] the number of accidents where the cyclists are involved may –in such case– be greater than for other road users. This is due to both, the larger differences in velocities of the motorized users and cyclists as well as poor visibility of the cyclists. A number of these cross the roundabouts as the pedestrians do pushing their bicycles, especially if there is no bicycle path.

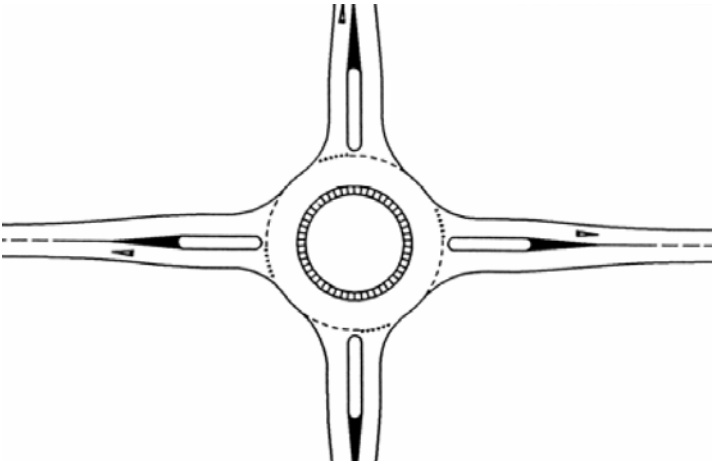

Fig. 1a. Roundabout with mixed traffic. Source: [4].

Fig. 1b. Roundabout with mixed traffic. Source: own work.

2.2 Sectioned Cycle Paths Adjacent to an Envelope with the Priority to Cyclists

Sectioned bicycle paths adjacent to a roundabout envelope with its inflow and outflow junctions provide the bicycle traffic with a spatial segregation from the vehicle traffic (Fig. 2a, 2b). The cyclists and vehicles have their own facilities, although there is no any physical barrier between them. In most cases the bicycle paths differ from the traffic lanes by the color and sometimes also by the surface structure. The cyclists receive priority as the drivers have to give way. Thus, the right of way to the oncoming bicycle traffic applies. However, according to research [1] such solution does not provide the cyclists with a sufficient level of safety and leads to many potentially dangerous situations. That includes as following:

- a risk of collision between the oncoming traffic and a cyclist on a cycle lane when a vehicle approaches the roundabout and enters the roundabout envelope;

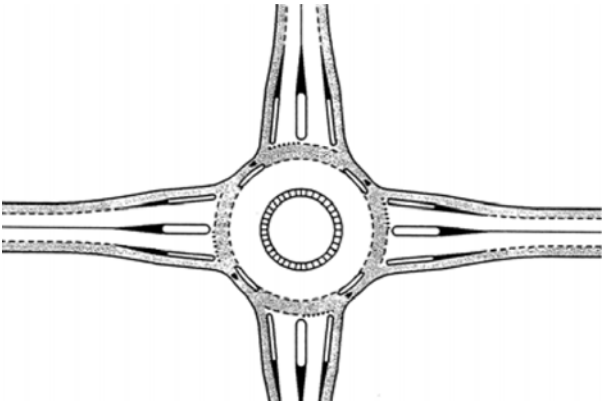

Fig. 2a. Roundabout with adjacent bicycle lanes. Source: [4].

Fig. 2b. Roundabout with adjacent bicycle lanes. Source: [5].

- a risk of collision when vehicle enters the roundabout envelope and a driver may not see the oncoming cyclist, especially when both use the same inflow junction;
- a risk of collision when drivers of the vehicles already circulating around the roundabout may not see a cyclist in a rear mirror (blind area), especially when the latter uses the cycle lane adjacent to the roundabout envelope.

2.3 Sectioned Cycle Paths with the Priority to Cyclists

Cyclists on a roundabout use the bicycle paths sectioned from a roundabout envelope by a central reservation either in form of an island elevated above the level of the roundabout or in form of a green belt. Such solutions ensure a sufficient level of safety to all cycle traffic as the cyclists crossing the approaching and exiting vehicle traffic receive priority. Hence the vehicle drivers have to give way and the right of way to the oncoming bicycles applies (Fig. 3a, 3b).

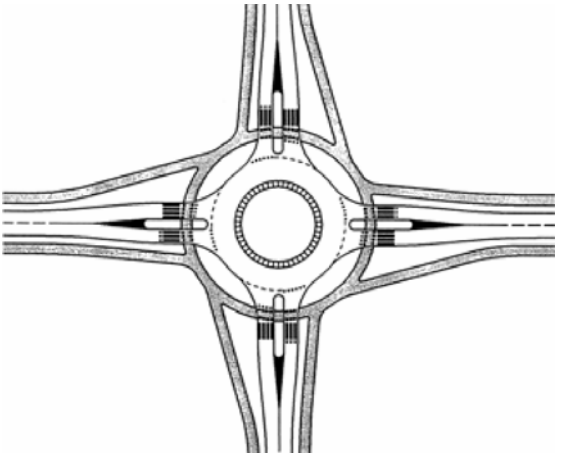

Fig. 3a. Roundabout with sectioned bicycle lanes. Priority given to the cyclists. Source: [4].

Fig. 3b. Roundabout with sectioned bicycle lanes. Priority given to the cyclists. Source: [7].

The cyclists ride on a sectioned path when circulating the roundabout. Safety of the cycle traffic depends on the mutual awareness of the presence of the bicycles and motorized vehicles in traffic.

2.4 Sectioned Bicycle Paths without the Priority to Cyclists

Cyclists on a roundabout use the bicycle paths sectioned from a roundabout envelope by a central reservation. The cyclists crossing the approaching and exiting vehicle traffic have to give way. Thus a priority rule to the oncoming vehicles applies (Fig. 4a, 4b).

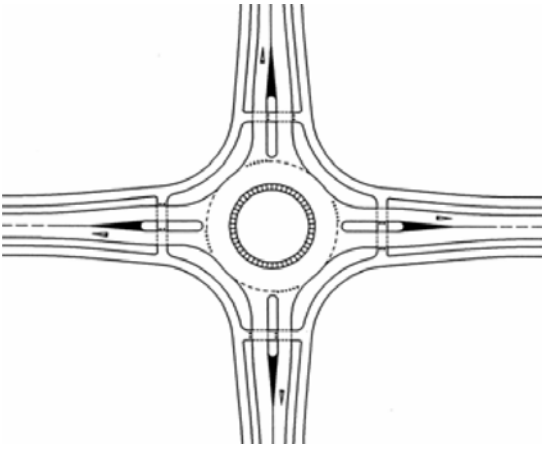

Fig. 4a. Roundabout with sectioned bicycle lanes. No priority given to the cyclists. Source: [4].

Fig. 4b. Roundabout with sectioned bicycle lanes. No priority given to the cyclists. Source: [6].

2.5 Footbridge for Pedestrians and Cyclists Elevated over an Intersection

A footbridge for pedestrians and cyclists in a shape of circle elevated over an intersection is a solution that eliminates all kinds of collisions between the vehicle traffic, pedestrian traffic and cycle traffic (Fig. 5a, 5b). There are four paths with a 3% slope each leading to the footbridge, which also allows skaters and handicapped people to

use the passage without difficulties. Such multilevel solutions one can find in Holland, in Eindhoven for that instance. They can be applied over any type of intersection, not only over the roundabouts.

Fig. 5a. Footbridge for pedestrians and cyclists elevated over an intersection. Source: [7].

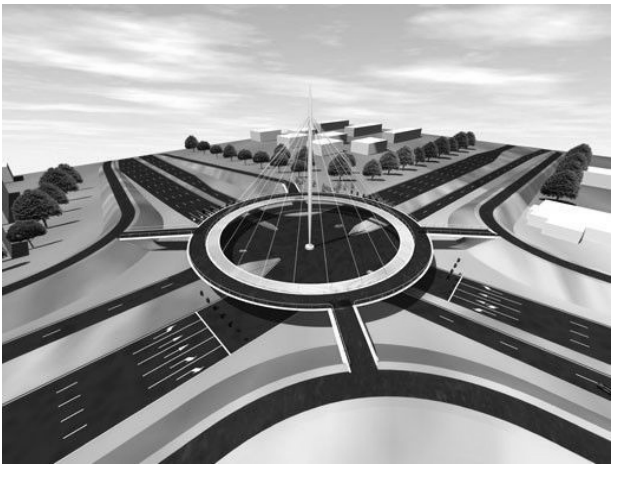

Fig. 5b. Footbridge for pedestrians and cyclists elevated over an intersection. Source: [8].

2.6 Sectioned Bicycle Paths under an Elevated Roundabout

Another solution eliminating all kinds of collisions between the vehicle traffic, pedestrians and cyclists is to build an elevated roundabout for all vehicle traffic and to design the cycle paths under the roundabout (Fig. 6a, 6b). This is a very interesting and yet a very simple solution in terms of the traffic organization and it provides the cyclists with a high level of safety. Differing from the majority of projects developed and solutions applied, this time it is the roundabout that has been elevated over the

ground level. This makes the usage of the passage much easier as the pedestrians and cyclists do not need to use deep slopes or cross the intersection via dark, narrow and sometimes even unsafe underpasses. Such solutions one can find mainly in Holland, in the Eindhoven area for that instance.

Fig. 6a. Sectioned bicycle paths under an elevated roundabout. Source: [4], [8].

Fig. 6b. Sectioned bicycle paths under an elevated roundabout. Source: [4], [8].

2.7 Roundabout with an Open-Up Bicycle Tunnel

The vehicle and bicycle flows run at two different levels (Fig. 7a, 7b). The vehicle flow runs on the ground level and the bicycle flow runs underneath the roundabout in a bicycle tunnel. For the social safety reasons a decision to open up the tunnel in the middle of the roundabout has been made. These solutions are applied to the open air areas in case of a significant volume of the cycle traffic flows in an intersection zone as well as frequent collisions involving the cyclists. Such solution can be found in Holland (in the Dronten area for that instant).

Fig. 7a. Roundabout with an open-up bicycle tunnel. Source: [7], [8].

Fig. 7b. Roundabout with an open-up bicycle tunnel. Source: [7], [8].

2.8 Roundabout with a Bicycle Path in the Middle of the Road

One of the most interesting although not that common solutions is an example of a bicycle roundabout in Lelystad, Holland. On this particular roundabout a lane for cyclists is to be found not on the outside, but in the middle of a traffic lane (Fig. 8a). As a result of such layout the drivers cannot overtake the cyclists on the roundabout envelope. They can only drive behind or in front of the cyclists, which effectively improves safety of the cyclists on this roundabout. The cyclists enter the roundabout via a bicycle path that makes one of the leg junctions. This pilot project came to existence in 2006 and as of now is still experimental.

Fig. 8a. Roundabout with a bicycle path in the middle of the road. Source: [7], [8].

When approaching the roundabout one can find special traffic signs that inform the drivers about the presence of cyclists in the middle of the road (Fig. 8b). Along with the emblem of a cyclist the caption reads: "Caution: bicycle roundabout. All vehicles ahead of or behind, NOT beside a cyclist."

Fig. 8b. Roundabout with a bicycle path in the middle of the road. Source: [7], [8].

3 Conclusions

All the solutions presented in the article have their advantages and disadvantages. Each time the choice of which solution to apply should be made independently and according to the location of the roundabout and all external factors having influence on how the traffic flows are forming.

One should also bear in mind that apart from the optimal traffic organization on the roundabouts, there are also the safety issues to be concerned about. Safety of a cyclist in the late hours depends mainly on the proper illumination of the roundabouts and all side streets in the area of those roundabouts as well as their visibility. A good visibility can be provided by wearing light-colored or fluorescent clothing and/or reflective accessories which will help other road users to see a cyclist in the dark or in poor light.

Riding a bicycle on the roundabout with the poor cycle infrastructure makes the bicycle users feel uncomfortable and less safely. A decision about using a bicycle as a means of transportation needs to be made after taking many different aspects into consideration. These factors include mostly the distance and time of travel, a degree of difficulty of the route, comfort and safety of the trip, noise and the possibility of leaving a bicycle in a safe place. There are much more issues to consider, but these are the most common. And the more concerns a cyclist has the more likely a bicycle will not be chosen as a means of transportation.

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