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SAFETY OF PEDESTRIANS AND CYCLISTS AT ROUNDABOUTS

Abstract: The paper presents the basic settings for achieving a safe intersection with a roundabout in terms of pedestrian and bicycle traffic according to regulations and guidelines from Austria and Germany. The ways of directing bicycle traffic in the area of the roundabout are given, further the variant with underpasses for cyclists below the roundabout, which a priori excludes collision points between motor vehicles and cyclists, then the median traffic island for separating traffic flows at roundabouts according to and the location of public transport stations near the roundabout, as well as the road marking and traffic signing of the roundabouts, all in the context of pedestrian and cyclist safety as "weaker" traffic participant.

Keywords: roundabout, pedestrian, cyclist, traffic safety, median traffic island, underpass, pedestrian crossing.

1. INTRODUCTION

Roundabouts are not popular with all motorists, although they are much safer than "normal" intersections. In addition, roundabouts are more favourable in terms of environmental pollution than ordinary intersections (less traffic noise and exhaust emissions) and are cheaper than them. The roundabout has fewer points of conflict and is clearer than a regular intersection, and vehicles are moving at lower speeds on them. It is also important to say that it is easy to qualify roundabouts as "more favourable" in a certain traffic sense compared to "normal" intersections, but it is necessary to justify something like that with appropriate design solutions and the quality of construction. Large roundabouts should not be planned in front of schools and kindergartens as well as in front of institutions for the blind and visually impaired, in front of homes for the elderly, in front of hospitals and other health units, as well as in places where pedestrians do not I can cross the road safely. Special attention when planning, designing and building (constructive measures) of roundabouts should therefore be paid to non-motorized road users - pedestrians and cyclists as "weaker" road users, and we will say something about that here.

2. MEASURES TO ACHIEVE A SAFE ROUNDABOUT IN THE MEANING OF TRAFFIC - PEDESTRIANS AND CYCLISTSREFERENCES

2.1 DIRECTION OF BICYCLE TRAFFIC IN THE ZONE OF SMALL ROUNDABOUT

The safety of pedestrians and cyclists in traffic depends mainly on the appropriate road marking and traffic signing of the roundabouts, the median traffic islands for the separation of traffic flows as well as the applied methods of managing bicycle traffic in the area of the roundabout. There are basically two ways of directing bicycle traffic in the area of the roundabout (Fig. 1):

a) Parallel routing of bicycle traffic (along the outer edge of the roundabout) (Fig. 1a). Although this way of directing is found in both foreign and domestic literature, it is by no means recommended for security reasons!

b) Independent routing (parallel to curbs or in the form of a concentric circle outside the roundabout) (Fig. 1b).

Bicycle traffic as mixed traffic together with motor vehicles on the roundabout, recommended for traffic loads max. up to 15,000 vehicles per day. It is recommended that cyclists ride in the middle of the circular carriageway, which prevents them from being overtaken by motor vehicles (Fig. 2).

Therefore, the variant on a special bicycle path at the edge of the roundabout is not recommended (Fig. 3) because in this way the safety of cyclists is significantly endangered, as motor vehicles use the rest of the roundabout to overtake cyclists. just get out of the roundabout and turn right, overlook a cyclist (who, to make matters worse, "thinks" he is absolutely safe if he rides on this special and most likely coloured bike path) who is still riding in a roundabout and who is in at that moment in a dead end with the driver of the motor vehicle and thus a collision occurs!

In addition, vehicles entering the roundabout can notice a cyclist (compared to a motor vehicle) who is currently riding on that special track, especially if he is driving fast and "suddenly" is created in front of the car!

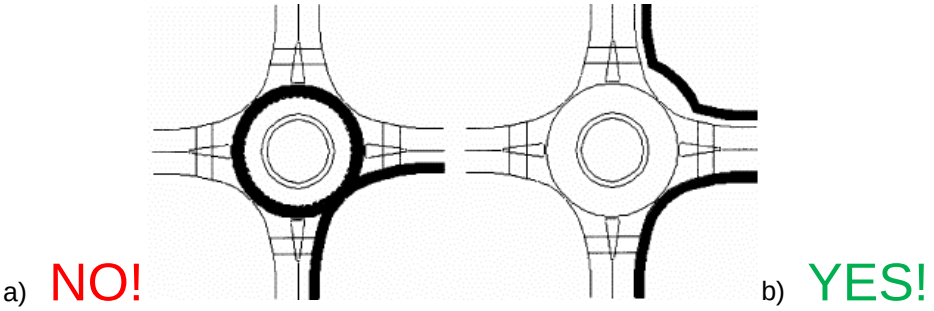

Figure 1. Two possible ways to direct bicycle traffic in the area of a small roundabout [1]

Figure 2. Bicycle routing in the area of a small roundabout on the circular carriageway - recommendation up to 15,000 vehicles / 24 h [1]

NO!

Figure 3. Directions of bicycle traffic on a special bicycle path on the roundabout - the safety of cyclists is significantly endangered! [1]

I can personally confirm that since I ride a bike a lot myself, that cyclists, for example with racing bikes they ride on the plain 35-40 km/h even faster. In addition, in recent years, E-Bikes or electric bicycles have become very popular in the West, so it is not uncommon for an older gentleman of the "sportier type" of at least 80 years of age to overtake me with such an electric bicycle! However, precisely because older people in particular underestimate the speed and power of these electric bikes, there has been a significant increase in traffic accidents with them in recent years!

According to the BMI - Bundesministerium für Inneres / Austrian Ministry of the Interior, in 2018, 40 cyclists were killed in traffic in Austria, of which 17 lost their lives on an electric bicycle - this is a new, so far the largest number! [3] Two-thirds of fatal traffic accidents with E-Bikes occurred outside populated areas and also two-thirds were fatal without the participation of other road users, through no fault of their own.

According to ÖAMTC - Österreichischer Automobil -, Motorrad - und Touring Club / Austrian Automobile Club, electric bicycles are especially attractive for the elderly. As many as two-thirds of all E-Bikes deaths are over 65, with an average age of 71. [3]

In Figures 4 and 5 we see two classic examples for directing bicycle traffic in the area of a roundabout using an independent method, i.e. a cycle path outside the carriageway of the roundabout.

All intersections of motor vehicles and pedestrians or cyclists must be at right angles, which as a result has the most correct shape of the field of view of all participants in the intersection. The result is also the fact that the points of conflict are only at the crossings over the arms of the roundabout, but that even there pedestrians and cyclists are (partially) protected by median traffic islands.

Figure 4. and Figure 5. Directions of bicycle traffic on special bicycle paths outside the roundabout [1]

2.2 UNDERPASSES FOR BICYCLISTS IN THE AREA OF THE ROUNDABOUTS

Another possibility regarding the safety of cyclists in the area of roundabouts is underpasses for cyclists. For this example, the roundabout "South" of the Lenzing bypass (Fig. 6) was chosen, a small town of only 5,159 inhabitants 5 km from Voecklabruck, the author's residence, in the construction of which the author himself participated while he was construction manager to a construction firm in Upper Austria.

The situation plan (Fig. 6) shows an underpass for cyclists, which is situated in a slight curve and which represents another possibility of conducting bicycle traffic at roundabouts: off-level crossing. In this way, all collision points are excluded on the one hand between motorized road users riding on the roundabout (above) and on the other hand by cyclists riding through the underpass (below).

The R6 - provincial cycling route, which is part of the international cycling route "Roman Cycling Route" (Roemerradweg), passes through this underpass (Fig. 7).

The Roman cycle path is 242 km long and leads from the German town of Passau in Bavaria (germ. *Bayern*), through the Innviertel area, further through the Salzkammergut (a beautiful part of Austria with several lakes translates to "*salt demesne*" or "*salt domain*"), where it passes through Lenzing and further through Voecklabruck and on to the oldest the town of Enns in Austria, located east of the capital of Upper Austria Linz. From there leads the so-called. Donau-Radweg (Danube bike path) along the Danube back all the way to Passau. Whoever wants, can of course sit on the train or on the boat to Enns and return to Passau.

What this underpass for cyclists looks like can be seen in Figure 8 and its cross section in Figure 9. The light profile of the underpass is 2.5 m high and 3.5 m wide (Fig. 9).

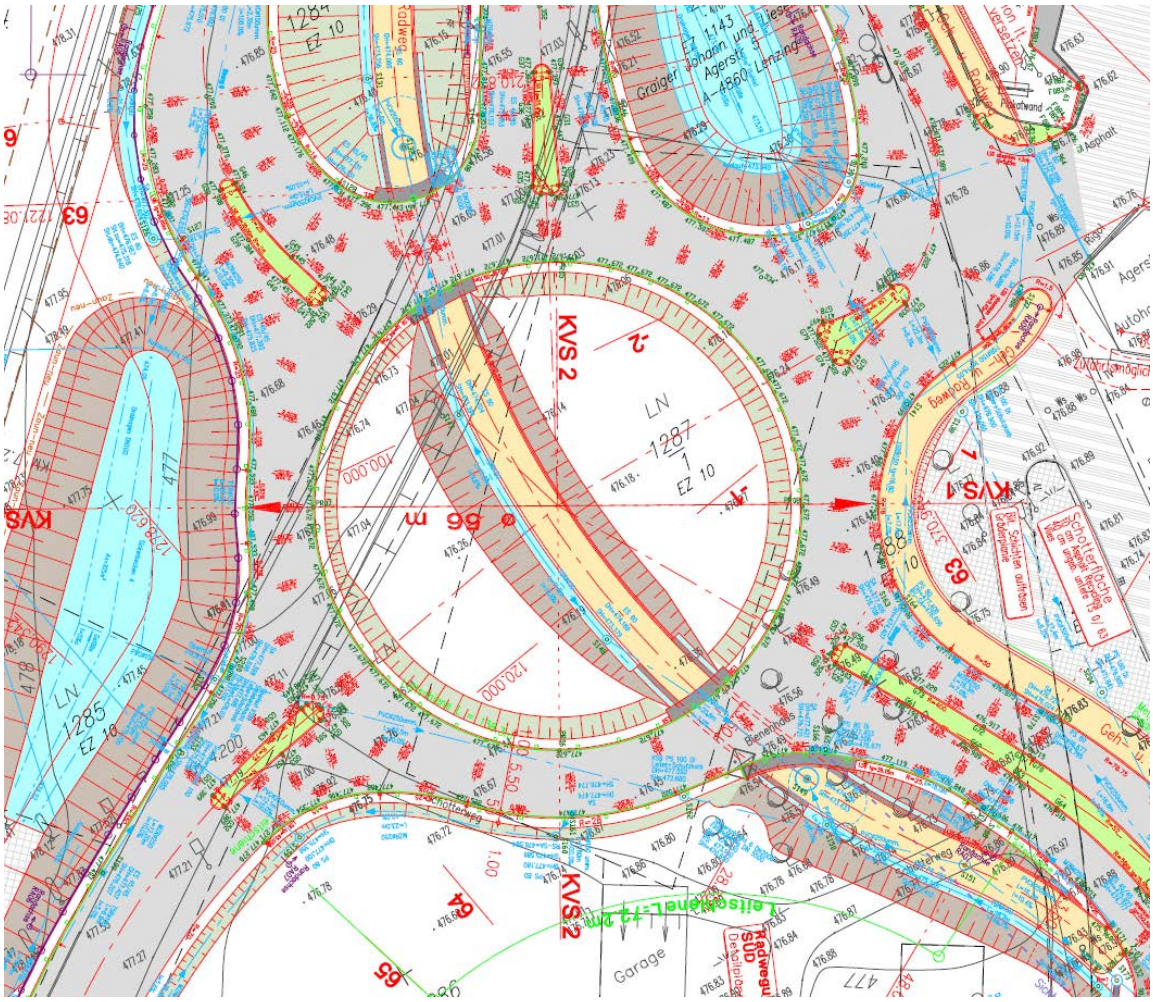

Figure 6. Situation plan of the roundabout "South" of the Lenzing bypass with an underpass for cyclists [5]

Figure 7. The international bicycle route marked "R6", the so-called "Roemerradweg" ("Roman Cycling Route") [6]

Figure 8. Underpass for cyclists KV „Lenzing South“ [author]

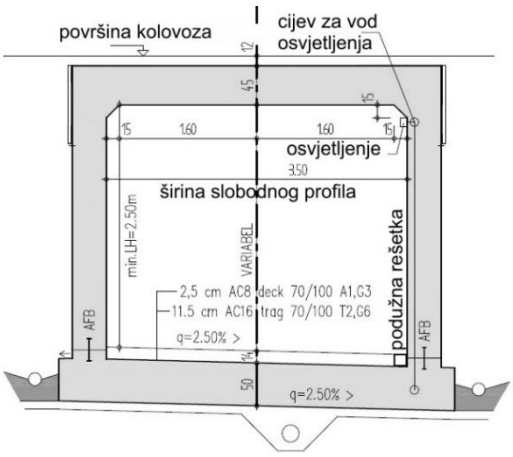

Figure 9. Underpass cross section [5]

3. MEDIAN TRAFFIC ISLAND ON THE ROUNDABOUTS

We can see in Figure 10 what the median traffic island for the separation of traffic flows should look like according to the guidelines for planning and construction of Upper Austria. The median traffic island should always be provided if possible and are also useful for mini roundabouts. They are placed between the entrances and exits at the roundabout arms to avoid wrong turns and to provide more traffic safety especially for pedestrians and cyclists. The width of the median traffic island is at least 1.60 m (RASt 06, 2006) [7] or 2.00 m (RVS 03.05.14, 2010) [2]. In the area of the crossing aid, the median traffic island must be constructed at least 2.50 m (Fig. 10). The median traffic island are to be bordered with kerbstones and lowered in the area of the crossing point as a 2-3 cm high low kerb. The median traffic island is to be placed 0.25 m from the circular roadway and its length is 12.00 to 15.00 m depending on the local space conditions. The width of the median traffic island at its tip is at least 1.10 m (width of the guide angle + 2 x 0.30 m). The distance between the pedestrian crossing (zebra crossing) and the circular roadway should be 6.0 m, so that a car can remain inside until the circular roadway is clear, without preventing the crossing with its rear part. The width of the crossing should be at least 2.50 m, but 3.00 m is better [4]. In the lane divider it is also possible to place an exit sign, taking care not to obstruct the visibility of all road users (Fig.10). However, the pedestrian crossing (zebra crossing) should not be too far away from the roundabout road, as this creates longer paths for pedestrians or the speed of the outgoing traffic flow becomes too high, which poses a danger to pedestrians.

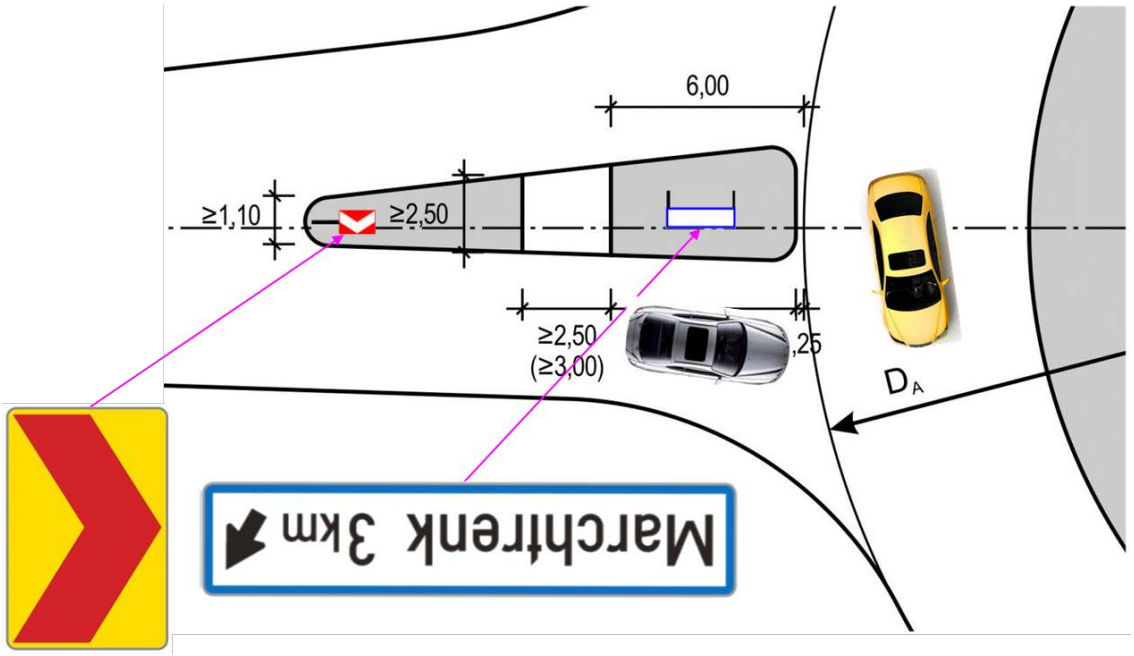

Figure 10. Dimensions of the median traffic island [4] (author's processing)

4. PUBLIC TRANSPORT STATIONS IN THE AREA OF ROUNDABOUTS

Public transport stations in the outgoing traffic flow should be located on a special traffic area outside the road (niche) (Fig. 11). Bus stops in the incoming traffic flow are situated according to the Austrian guideline RVS 03.05.14 [2] in the form of stops on the road without the possibility of overtaking a stopped bus, which physically "protects" pedestrians crossing the pedestrian crossing in front of the bus, so this is one from pedestrian protection measures (Fig.11).

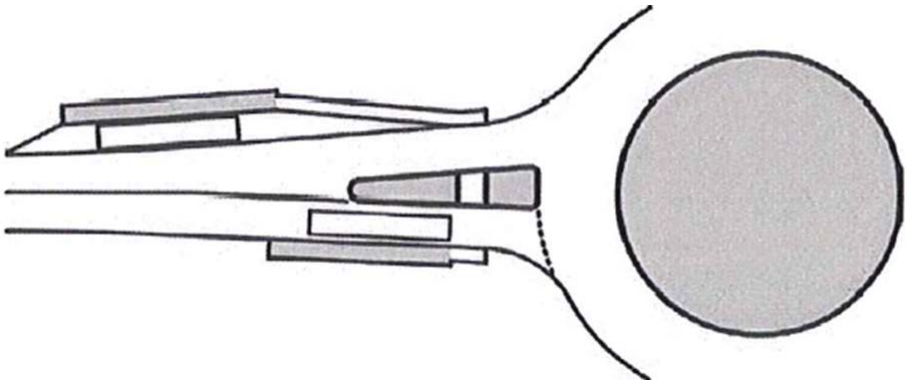

Figure 11. Situation of public transport stations near the roundabout [2]

5. THE ROAD MARKING AND TRAFFIC SIGNING OF THE ROUNDABOUTS

Figure 12 shows an example from the author's second book [16]: plan (original) scale 1: 500 horizontal and vertical signalization of the roundabout on the main road B10 Kugelkreuz in Lower Austria, where all signalling elements are represented roundabouts including hiking and biking trails and crossings. The same picture clearly shows the above-mentioned method of conducting bicycle traffic outside the roundabout - on a special pedestrian-bicycle path (German: Geh- und Radweg) (Fig. 12). Another possibility of increasing the safety of pedestrians and cyclists in traffic at intersections with roundabouts, as well as at "normal" intersections, are the so-called three-dimensional zebras. One of the most beautiful cities in Austria, Salzburg is about a 50-minute drive from the author's residence Voecklabruck. Here we see the first three-dimensional zebra in that city at the roundabout in front of the large shopping centre "Europark". (Fig. 13).

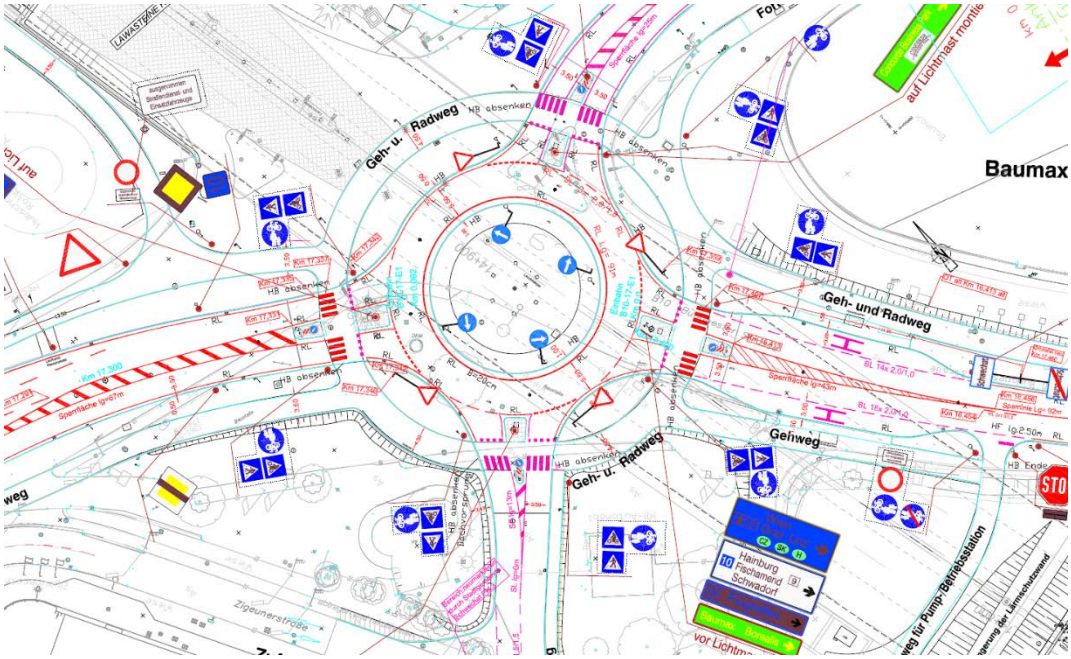

Figure 12. The road marking and traffic signing of the roundabout B10 Kugelkreuz B10 with special walking and cycling trail (germ. *Geh- und Radweg*) [8]

Figure 13. The first 3D pedestrian crossing in the city of Salzburg at the roundabout "Europark" [9]

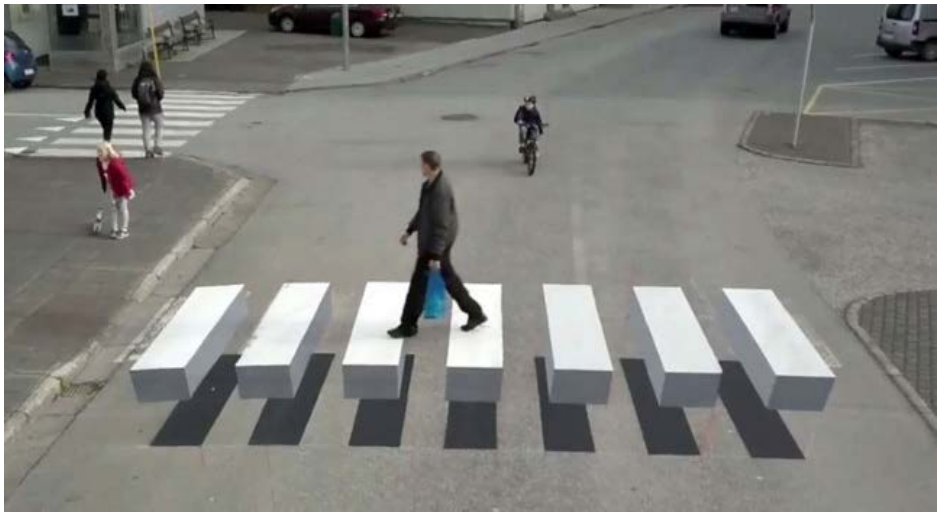

Figure 14. 3D pedestrian crossing as a means to increase pedestrian safety on roads [10]

However, the full three-dimensional effect of this optical illusion is only achieved when the observer is a little further away from this 3-D zebra as in Figure 14. With the illusion, pedestrians seem to hover over white blocks “normal” intersection) and thus contributes to even greater safety of pedestrians and cyclists in traffic.

6. CONCLUSION

All the above measures to achieve a safe roundabout in terms of pedestrian and cyclist traffic are very important when planning, designing and building roundabouts. Based on scientific research and statistics of pedestrian traffic accidents at roundabouts, the following can be concluded:

- Safety of pedestrians and drivers of motor vehicles on the so-called. "Mini-roundabouts" (roundabouts with inscribed circles with a diameter of 13 m to 22 m [12]) and "small roundabouts" (roundabouts with inscribed circles with a diameter of 26 m to 40 m [12]) compared to other intersections is especially large.

- Traffic accidents with injuries (pedestrians and cyclists) at roundabouts are rare because the speed of motor vehicles in roundabouts is low, traffic conditions are clear and simple and pedestrian and / or bicycle crossings over the arms of the roundabout are short and at right angles to the arm of the roundabout [11].

- Roundabouts significantly reduce the speed of traffic on sections of the road before and after those intersections in the length of 60 m.

- Urban roundabouts should have zebra crossings and / or bicycle crossings located on traffic separation islands at all ends of the roundabout where pedestrians and / or cyclists cross, thus contributing to unambiguous, simple and clear regulation of priority rights passage.

- One-lane roundabouts are safer for cyclists than two-lane ones, because the vehicle cannot overtake the cyclist or cross his path. Cyclists at one-lane intersections should ride in the middle of the roundabout and never along its edge.

- There is no need to situate special bicycle paths on the roundabout because practice has shown that and numerous studies, for example. [13] [14], as it is very dangerous for cyclists and it is better to even give up a roundabout than to use one such dangerous solution. One such bike path on a roundabout gives a false and deceptive sense of security to cyclists! In essence, this "adds" another "lane" on the roundabout and thus doubles the number of conflicting points. Vehicles can thus overtake and intersect cyclists. In addition, one such bike path "forces" the cyclist to ride along the edge of the roundabout, which gives the impression that the cyclist wants to get off the roundabout even though he is still riding on it.

- The effect of reducing speed at less congested intersections can be further increased by partially paving pedestrian and/or bicycle crossings over the arms of the roundabout.

- A joint pedestrian and bicycle crossing should be designed, because this intensifies the optical interruption of the road even more.

For the author personally, roundabouts are an extremely important and above all interesting topic and that was the main reason why the author invested six full years of writing books in Montenegrin: Basics of Roundabout constuction, Book I - General Part, Book II - Projects of Roundabouts Implemented in Austria, which show the design and construction of the same in German-speaking countries.

My new third book in Montenegrin printed in black and white and also in colour called: "Road constructions in German speaking countries - design, construction and maintenance". This reference book is meant to be like an encyclopaedia and it is intended for all those involved in highway engineering, such as universities, planners, designers, construction companies, experts and technical departments of municipalities and federal states. The book is a comprehensive guide to road construction in German-speaking countries and it is an extra-ordinary, very opulent and accomplished work with 934 pages, 1160 figures and 135 tables.

Open the link and scroll down:

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The book chapters are:

1. History of the road construction
2. Pavements in modern road construction
3. Flexible pavements construction
4. Rigid pavements construction
5. Paving blocks and paving flags, paving stones and paving slabs, curb stones and kerb units
6. Airfield pavements
7. Pavement condition assessment
8. Road maintenance

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