Slovenian fifteen-year experiences with roundabouts

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Abstract—During past almost fifteen years in the Republic of Slovenia the roundabouts have become more and more interesting for both designers and investors.

Our deeper interest for roundabouts started in last decade and until that time, in Slovenia we practically had no significant experiences with roundabouts and their advantages in road traffic.

When Slovenia became an independent country in the beginning of 90s, the need for establishing new legislation for the field of road construction and road traffic appeared. Among many other measures, the Slovenian Traffic Ministry founded the Group for Roundabouts, and its main task was preparation of guidelines for planning and constructing of roundabouts. The Group has finished its work in May 1999 and the final version of guidelines is in the legal procedure.

About fifteen years after the "new wave" of roundabouts has flooded Slovenia, at the moment, when there are about hundred roundabouts installed all over the country and when further increase of their number is foreseen, there is an opportunity for a general review of process concerning roundabouts in the Republic of Slovenia.

In the paper the Slovenian experiences about roundabouts in build up areas are presented.

Index Terms—roundabouts

I. INTRODUCTION

During past about fifteen years in the Republic of Slovenia roundabouts have become more and more interesting for both designers and investors. Until that time, in Slovenia we practically had no significant experiences with roundabouts and their advantages in road traffic.

When Slovenia became an independent country in the beginning of 90s, the need for establishing new legislation for the field of road design and road traffic appeared. Among many other measures, the Slovenian Ministry for Transport founded the "Group for Roundabouts", and its main task was preparation of guidelines for planning and designing of roundabouts. The Group has finished its work in May 1999 and the final version of guidelines was accepted in May 2000.

Today, fifteen years after first roundabout of the "new wave" we have 102 roundabouts and some more under construction.

II. THE HISTORY

Considering the chronic lack of professional literature on roundabouts in the first stage, the excess of professional literature, manuals and guidelines of other countries in the second stage, the lack of our own guidelines for roundabouts in the third stage and the number as well as the consequences of traffic accidents, we can affirm with complete responsibility that both, the designers and the contractors, did their work professionally, with a high measure of quality.

The process of introducing roundabouts into the Republic of Slovenia had a number of participants, who, although a little later, also joined in. Without their co-operation, the process would be much less successful. These are the road-police, media, driving schools, etc. Especially media, unlike driving schools, are the major means of providing information to the largest number of users - to PCU drivers, pedestrians, as well as cyclists.

After initial enthusiasm at introducing the first roundabouts into Slovenia; in cities Ljubljana, Maribor (Figure 1), Koper, Velenje (Figure 2), Gorica …, first questions concerning the justification of their installation and actual traffic safety, which they provide, appeared. Considering that roundabouts in Slovenia where at the time a novelty (with exception of some rare earlier examples), such caution is completely understandable.

There was namely no assurance that roundabouts in Slovenia would prove themselves appropriate, like they did abroad. With regard to the fact that fifteen ten years ago roundabouts were practically an innovation, there were some hindrances and expectations of effects, opposite to those, which roundabouts were actually designed for.

The lack of our own guidelines forced the designers to choose among foreign guidelines. Thus, the choice of a certain guideline depended on designer subjective estimation and on literature, which was attainable at that time. This caused a partial disunity at designing the first few roundabouts...
roundabouts in Slovenia. In other words, every roundabout was designed according to different guidelines. This is objectively understandable; as, until recently, there was no official or individual person, who would with his experience and theoretical knowledge of roundabouts be able to decide with certainty, which of the foreign guidelines should be taken as standard in Slovenia.

However, the direct application of foreign guidelines for roundabouts in Slovenia would be unacceptable and nonsensical, it would namely not be a result of actual traffic circumstances, and would at most cause unsuitable (if not negative) effects.

In spite of the facts, which have already been mentioned in the text above, roundabouts turned out well, even right after introducing them into Slovenia. Significant at that point were the designers and other institutions (especially universities), which took part at working out estimations about the suitability of the realizations and of the projects in general.

III. USAGE AREA

General experiences with roundabouts in Slovenia do not differ from those in other countries, which have been constructing them for decades. The installation of roundabouts in Slovenia is suitable and recommended mainly at intersections:
- of X, Y, A and K types (sharp intersection angle),
- of F and H types (two three-arm junctions close by),
- of larger number of arms (five or more),
- which are especially exposed to arising of traffic accidents with heavy consequences,
  - with excessive traffic speeds on approaches,
  - on areas, where driving conditions change instantly (i.e. at the ends of high-speed sections (motorways), at the entries into urban areas (Figure 3), on motorway exits…),
  - in the case of excessive traffic speeds on major road,
  - where posting of traffic lights is, from any reason, not justifiable,
- as a measure of traffic calming.

Thus, in some cases in Slovenia, the installation of a roundabout is the only acceptable solution (for instance intersection of a larger number of arms - five or more). In other cases (in junctions with excessive speeds of entering traffic, in case of sharp intersection angle, measure of traffic calming …), it appears only as one among the number of possibilities. Therefore, there is no universal "prescription", which would determine the usage of roundabouts in Slovenia. Each case is treated separately, according to its own features and circumstances.

IV. TRAFFIC SAFETY IN SLOVENIAN ROUNDABOUTS

The aim of this part of the article is to present the general level of traffic safety at Slovenian roundabouts and some of the forms and characteristics of traffic safety incidents at roundabouts in Slovenia today.

The first results of the Slovenian roundabouts` traffic safety analysis were introduced in 1997, and the second in 2004, both with a precise information on the number and the consequences of traffic accidents, given by the Sector for road traffic of the Ministry of the Interior of the Republic of Slovenia.

The purpose of the Slovenian roundabouts` traffic safety analysis was not searching for faults, which might be made by designers. The goal of the analysis was to ascertain the sorts and features of traffic safety phenomena in Slovenian roundabouts and to determine their common negative features.

For more concrete evaluation of roundabouts’ traffic safety, one has to be conscious not only of the analysis data, but also of two other circumstances. The first one is the "gray field" - a certain number of traffic accidents, which have not been reported to the police. The second one is that the existing method of collecting and processing the topical traffic safety data (which are being managed electronically by the department of the Ministry of Internal Affairs), has to be accommodated to roundabouts. Because of yet incomplete adjustment of computer data-management it is harder to obtain completely relevant data for particular roundabouts.

From the number of the traffic accident causes on Slovenian roundabouts, traffic speed was the most frequent one (63% of all traffic accidents). The second one was incorrect movements of vehicles, in which the drivers, when
changing the traffic lane, did not take necessary measures to assure safe realization of their traffic maneuver (10.1%). The third place goes to the inappropriate safety distance (7.9%) while the fourth belongs to violating the give-way regulation (6.1%). What follows is: incorrect position of the vehicle (4%), incorrect driving direction (1.8%) and finally, vehicles carrying inappropriately loaded freight (0.7%).

From the viewpoint of the causes of traffic accidents at roundabouts in Slovenia (since their construction till now) it may be established that most of the traffic accidents (50%) occurred due to excessive speeding. Shifting between lanes represents the second biggest cause (18%) whereby drivers failed to guarantee the safety of their actions while changing lanes. Inadequate safety distance takes the third place (18%) due to which cars collide upon driving on to the roundabout.

The comparison of both analyses shows that the percentage of cases of excessive speeding significantly decreased. This indicates that the participants have got the message and have mastered the rules of driving through roundabouts which, with their appropriately built joining roads, do not allow for high speeding. They, in this way protect the rest of the participants in traffic while at the same time allowing a swift flow of traffic. It may still be observed that drivers pay insufficient attention to driving in the right lane (changing lanes on the roundabout) as the percentage of this cause of accidents has increased (21%).

A review of the results of the analyses shows that traffic safety significantly improved after the introduction of roundabouts and that the roundabouts in Slovenia have, at the beginning of their operation, fulfilled their purpose and have, therefore, justified the expectations.

The time period of three years also indicates that the participants in traffic have much better knowledge of the rules of driving through roundabouts.

V. MEASURES OF ASSURING A TRAFFIC-SAFE ROUNDABOUT IN SLOVENIA

After examining the suitability of the location and of the position in the global road network, it is necessary in Slovenia, at the modeling of a roundabout, to follow certain instructions (directions), which have a direct influence on the level of traffic safety of all types of participants. The instructions concern geometrical modeling, which provides transparency, visibility and comprehensibility:

Arms of a roundabout should enter the roundabout as right angled as possible (Figure 4). Tangential alignment of an approach into the roundabout causes incomprehensibility of the give-way principle, high approaching speeds of vehicles, obscured visibility at entering the roundabout and collisions of vehicles at the entries.

The speed of an approach depends directly on the approach radius. An excessive radius causes excessive approach speeds, while insufficient radius may cause impacts into the central island or undesirable passages onto the inner lane of the circulatory flow.

Curvature of the driving curve (deflection) through the roundabout is of most significant importance for traffic safety at driving through the roundabout. The curve has to have the shape of a double S-curve, which is formed by three radii of adjusted size (Figure 5). Stronger curvature of the curve causes lower driving speed on approaches and departures and by that greater traffic safety in the roundabout. Deflection can be influenced in two ways, by changing the size of the central island (a better way of changing deflection, but often not feasible) and by changing the shape of pedestrian island (a less effective way, but often feasible).
Separate - independent managing of bicyclists’ traffic in the roundabout area is the safest technique of managing bicyclists (Figure 7). All intersections of motor vehicles with bicyclists (and pedestrians) are performed right angled. Thus the correct form of sight distance is achieved. The only conflict points, which still remain present, are the crosswalks across the arms of the roundabout, where bicyclists (and pedestrians) are (at least partially) secured by pedestrian islands.

Pedestrians’ safety on Slovenian roundabouts depends mainly on pedestrian crossings (Figure 7) and transparency, a little less on the design of pedestrian islands, and vertical and horizontal road signs. A distance of one to two passenger car lengths between the outer edge (exit) of the roundabout and the pedestrian crossing is recommended. In this way pedestrians and bicyclists do not strongly obstruct the motor traffic, which enters the circulatory flow and by that, the permeability of the roundabout is higher.

Pedestrian islands (splitter) should be adapted to the size of the roundabout and to the expected traffic speed in the roundabout. In big roundabouts, the use of funnel-shaped pedestrian islands is recommended (Figure 8), while in small roundabouts the use cone-shaped islands is the most appropriate (Figure 7).

Lighting of roundabouts determines the level of traffic safety at night. The lighting of all arms of the roundabout and of the central island is strongly desired. In large roundabouts lighting columns should be placed at the edge of the central island, while in small roundabouts the lighting in the center of the central island is sufficient.

Arrangement of the central island (Figure 9) (horticultural arrangement, fountains, monuments and other objects in the central island) is of considerable importance for insuring traffic safety in the Slovenian roundabout.

Regardless of the esthetic values, the arrangement of the central island has, from traffic safety point of view, also some practical values:

- with appropriate shaping of the land inside the central island (or with fountains, monuments, sculptures and other objects) it is possible to clearly warn the drivers, that they are approaching the roundabout,
- with partial covering up (hiding) the vehicles on the opposite side of the roundabout, it is possible, without obscuring the necessary visibility, to eliminate the negative effect on the driver, which can be caused by the look on the traffic movement of the entire roundabout.
- plantations in the central island are a good background for traffic signs and direction boards, which are placed on the central island.

VI. CONCLUSION

The article is a short summary of the fifteen years process of introducing roundabouts into Slovenia, which was performed intensively in the last ten years.

We can affirm now with complete responsibility that all of the participants in this process, the universities, the designers, the reviewers and the contractors, did their work
professionally, with a high measure of quality.

This is a result of several years-studying of foreign regulations, of analyzing their use in Slovenia, of working out our own regulations for designing of roundabouts and of monitoring and estimating their suitability on a high number of roundabouts in Slovenia.

VII. ACKNOWLEDGMENT

All photos have been made by the author of the article

REFERENCES


