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NEW TYPE OF ROUNDABOUT: ROUNDABOUT WITH "DEPRESSED" LANES FOR RIGHT TURNING – "FLOWER ROUNDABOUT"

ABSTRACT

Recently, many of the foreign traffic-safety analyses point out the low level of traffic safety in multi-lane roundabouts. This problem is resolved in several ways in different countries; however, the solution, whereby the number of conflict points is diminished (e.g. turbo roundabout) has proven to be the most successful. However, the turbo roundabout also has its deficiencies: it has conflict crossing points and larger reconstruction of the existing two-lane roundabout is needed when the turbo roundabout is to be implemented instead of the existing one. In the paper a new type of roundabout has been introduced; the roundabout with "depressed" lanes for right turning ("the flower-roundabout"). Financially speaking, the main advantage of the new type of roundabout is that it can be implemented within the dimensions of the already existing "normal" two-lane roundabout. From the traffic-safety point of view, the main advantage of the new type of roundabout is that it has no crossing conflict points.

KEYWORDS

traffic safety, roundabout, turbo roundabout, roundabout with "depressed" lanes for right turn

1. INTRODUCTION

Lately, a growing number of foreign analysis point out to poor traffic-safety characteristics of "normal" multi-lane roundabouts and bad experiences related thereto [1]. For this reason, many countries are looking for a solution of what to do in these existing roundabouts, in order to improve the level of traffic safety [2, 3].

Different countries tackle this problem in different ways, which can be divided into four groups. A higher level of traffic safety in "normal" multilane roundabouts can be achieved by:

- *decreasing the number of driving lanes in the circulatory carriageway*: not a good solution, because the roundabout capacity is decreased,
- *decreasing the number of driving lanes at entries/exits*: not a good solution, because the roundabout capacity is decreased,
- *increasing the outer roundabout diameter (whereby, the available length for weaving in the circulatory carriageway is increased)*: financially very demanding,
- *decreasing the number of conflict points*: a good compromise between the finances on the one side and the increased transmission capacity and traffic safety level on the other.

Lately, many countries have been solving the problem of low traffic safety of "normal" two-lane roundabouts by adopting the last of the above-mentioned methods – by decreasing the number of conflict points. One of the ways to decrease the number of conflict points is the turbo roundabout [4, 5].

2. RECENT SLOVENIAN EXPERIENCE WITH TURBO ROUNDABOUTS

All five of the Slovenian turbo roundabouts (Figures 1 and 2) are subjected to monitoring and analyses of their operation, since they are still "fresh" and we cannot yet guarantee that they shall be as successful as in the Netherlands, whereas certain dimensions of the Dutch typical roundabout were also changed in order to suit the Slovenian conditions. In addition, in Slovenia, specific problems are encountered because of the weather conditions (cleaning the snow from the turbo roundabout with a plough).

However, in general, we can establish that turbo roundabouts in Slovenia have met the expectations as concerns the large capacity [6] and particularly the high level of traffic safety. It must be stressed at this point that traffic accidents in Slovenian turbo roundabouts are an exception and not a rule and these accidents normally result only in material damages.

Figure 1 - The first Slovenian Turbo Roundabout; city of Koper 2008

Figure 2 - The second Slovenian Turbo Roundabout, city of Maribor 2008

However, a four-leg turbo roundabout has 6 merging conflict points, 4 diverging conflict points [7], unlike the "normal" two-lane roundabout it has no weaving conflict points; nevertheless, it does have 4 crossing conflict points, which is the drawback of this type of roundabout [8] (*Figure 3*).

In two out of five Slovenian turbo roundabouts the drivers' hesitance (fear, confusion, insecurity) has been noticed, when they enter the turbo roundabout on the inner circulatory carriageway (*Figure 4*).

The fact is that in both cases, the driver at this traffic manoeuvre crosses a very heavy traffic flow and enters the second, equally heavy traffic flow, which results in the feeling of insecurity and danger by the driver. Therefore, these drivers enter the turbo roundabout very slowly or only when the vehicles in the roundabout are at a great distance from them.

Therefore, the crossing conflict points in the turbo roundabout have a significantly larger negative effect than was expected (at least at the beginning of the introduction).

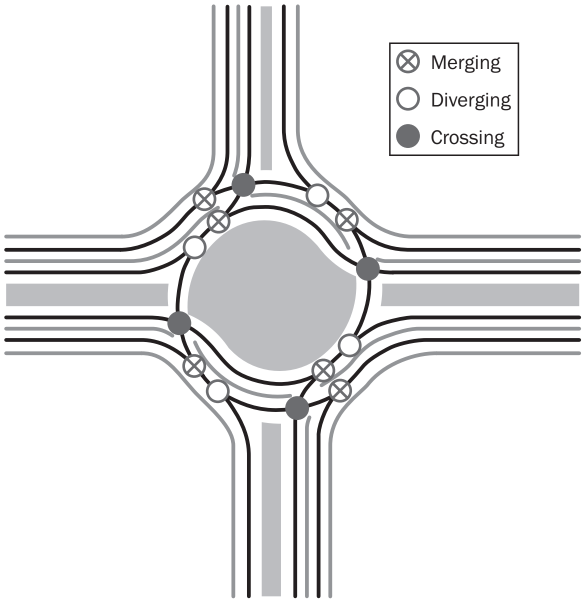

Figure 3 - Conflict points in four-leg turbo roundabout

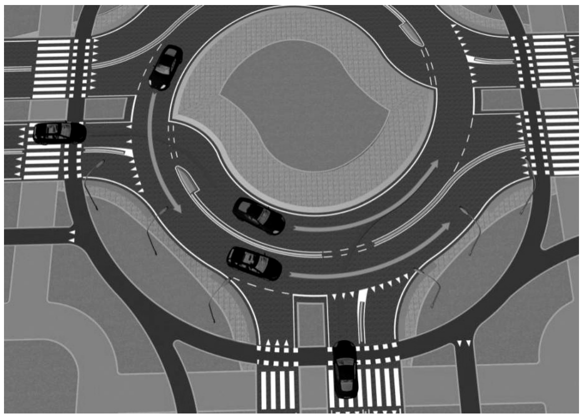

Figure 4 - Crossing conflict point at the entry on the inner circulatory carriageway from the inner lane at the entry

Notwithstanding the good experience with the turbo roundabouts in Slovenia, the question is: *What to do with the existing, less safe, "normal" multi-lane roundabouts?*

It would be an illusion to expect (mostly for financial reasons) that they could all be reconstructed into turbo roundabouts!

3. ROUNDABOUT WITH "DEPRESSED" LANES FOR RIGHT-TURNING

3.1 Basic characteristics

There is a question, whether it is possible to combine positive characteristics of different types of roundabouts, while at the same time eliminating their negative characteristics or: *Is it possible to eliminate crossing and weaving conflict points in the existing* *“normal” roundabouts and thereby achieve high level of traffic safety without decreasing the roundabout capacity?*

The solution is the roundabout with “depressed” lanes for right-turners.

One of the basic characteristics of the roundabout with “depressed” lanes for right turning is the same as in the turbo roundabout – physically separated traffic lanes in the circulatory carriageway [9, 10].

The second characteristic of the roundabout with “depressed” lanes for right turning is that the right-turners have their own separated traffic surfaces (*Figure 5*). This causes that the inner circulatory carriageway is used only by vehicles which drive straight through the roundabout (180°) or turn by three quarters of a circle (270°).

By physically separating the right turning traffic flow, a one-lane roundabout is obtained, where (unlike the case of turbo roundabout) there are no crossing conflict points; however, (unlike the case of “normal” two-lane roundabout) there are also no weaving conflict points.

Weaving conflict points transfer from the circulatory carriageway (in the curve) to the road section before the roundabout (usually a straight line), which is a safer solution from the traffic safety point of view.

However, probably the best characteristic of the roundabout with “depressed” lanes for right-turners is that it is implemented within the existing “normal” two-lane roundabout. Unlike the turbo roundabout, there is no need to move the outer kerbs of the circulatory carriageway, and therefore no additional buying of the surrounding land is required. At the reconstruction of the “normal” two-lane roundabout into the roundabout with “depressed” lanes for right turning, all the kerbs of the circulatory carriageway, splitter islands and access roads remain in the same position.

3.2 Construction of a roundabout with “depressed” lanes for right turning within the existing “normal” two-lane roundabout

In order to transform the existing “normal” two-lane roundabout into the roundabout with “depressed” lanes for right-turners, another circulatory carriageway towards the centre of the roundabout must be implemented and splitter islands must be prolonged towards the central island [10].

The reconstruction of the existing “normal” two-lane roundabout into the roundabout with “depressed” lanes for right-turners is performed in four steps (*Figure 6*):

Step 1: additional circulatory carriageway towards the centre of the roundabout is implemented;

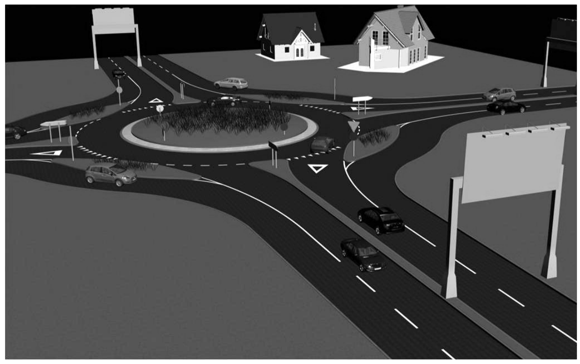

Figure 5 - The roundabout with "depressed" lanes for right-turners

Step 2: construction lines of entries and exits are prolonged;

Step 3: splitter islands are prolonged for one circulatory traffic lane towards the centre of the roundabout;

Step 4: redundant surfaces are rearranged into green areas.

Because the shape of the splitter islands, created by the reconstruction of the “normal” two-lane roundabout, looks like a flower, it can be called the ”flower-roundabout”.

This solution is possible in four-lane as well as in two-lane roads. In the case of a two-lane road, an additional, sufficiently long traffic lane is implemented, directly before the entry/exit.

3.3 Capacity comparison between the “flower-roundabout”, “normal” two-lane roundabout and turbo roundabout

The calculation was performed by using the micro-simulation package PTV VISSIM (*Figure 7*). The analysis included congestions and queue lengths for four variants of traffic loads (750, 1,000, 1,250 and 1,500 vehicles in the main traffic direction in the peak hour) and for four variants of right-turners (40%, 60% and 80% right-turners on the main traffic direction). In all scenarios 10% of the main traffic stream on minor streams were added [9].

Results of the micro simulation show that there are no significant differences between the flower roundabout, normal and turbo roundabout, at low traffic loads. Congestions and queue lengths are approximately the same.

At higher traffic loads, the differences in favour of the “depressed” roundabout occur when the percentage of right-turners approaches 60% of the total value of vehicles in the main traffic direction (Figures 8, 9 and 10).

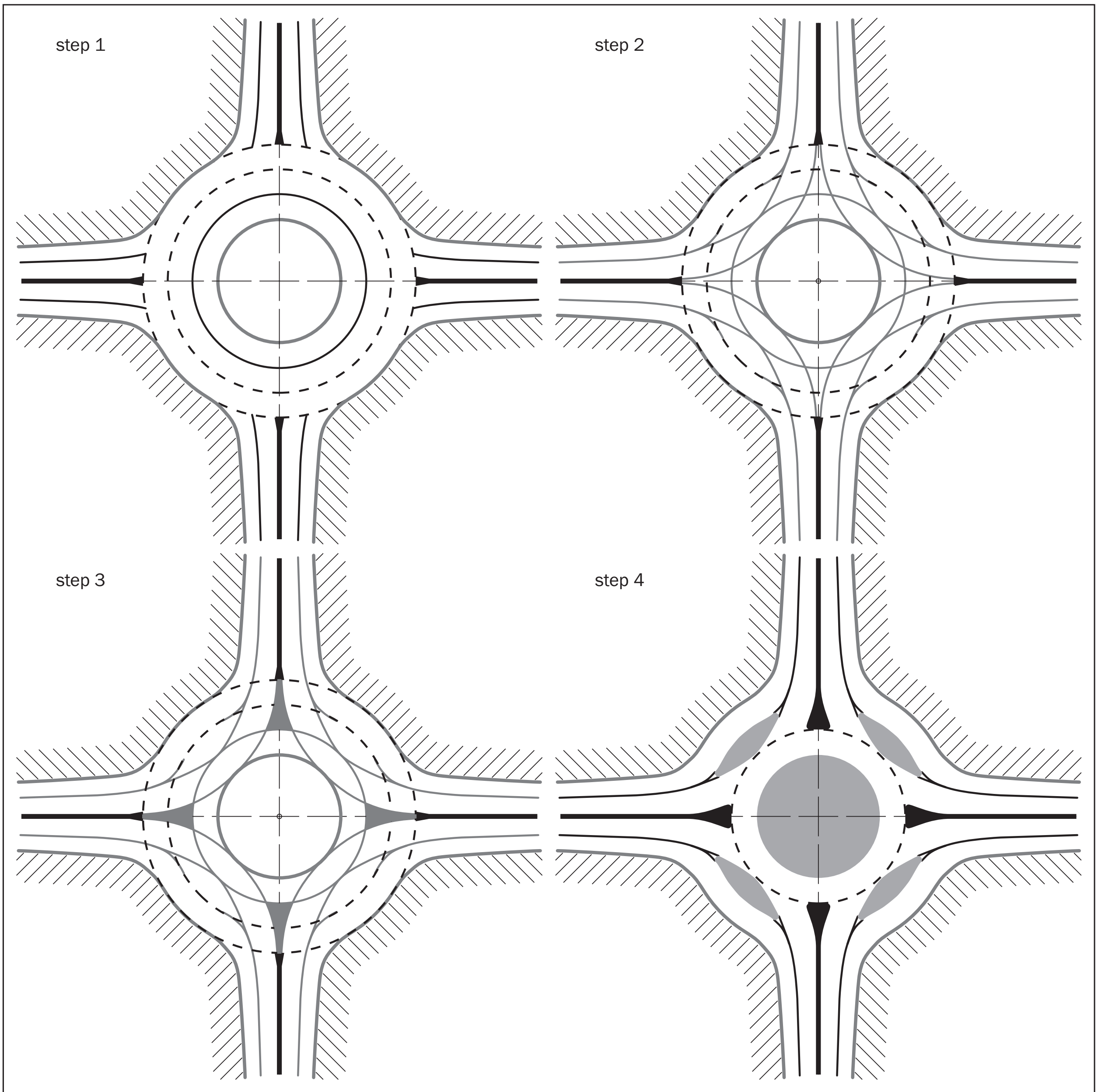

Figure 6 - Procedure of reconstructing the existing "normal" two-lane roundabout into the roundabout with "depressed" lanes for right-turners

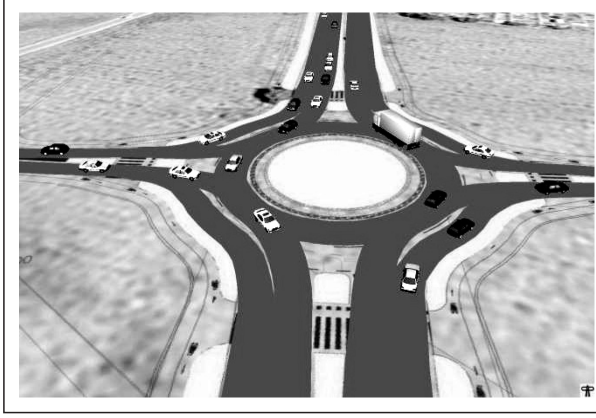

Figure 7 - The mathematical model and 3D simulation of "depressed" roundabout with PTV VISSIM 5.20

Compared to the "normal" two-lane and "turbo" roundabout, the "flower" roundabout shows its advantages when the larger part of traffic on the main traffic route is the direction of right-turners. Delays in the "80%" scenario and loads of "1,250" are 20.02s in "flower" roundabout (level of service; LOS = C), in "normal" roundabout these are 40.2s (LOS = D), and for "turbo" roundabout 66.4 s (LOS = D).

The "flower" roundabout "burns-out" at the moment when the one-lane roundabout capacity is exceeded.

The idea of the roundabout with the "depressed" lanes or the "flower roundabout'' is registered with the patent office for the potential need of proving the copyright within the EU [10].

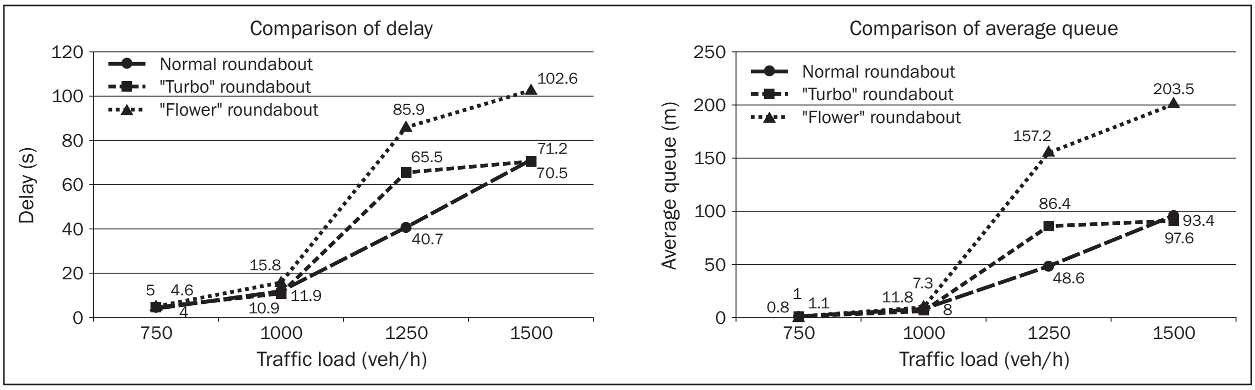

Figure 8 - Scenario with 40% of right-turners

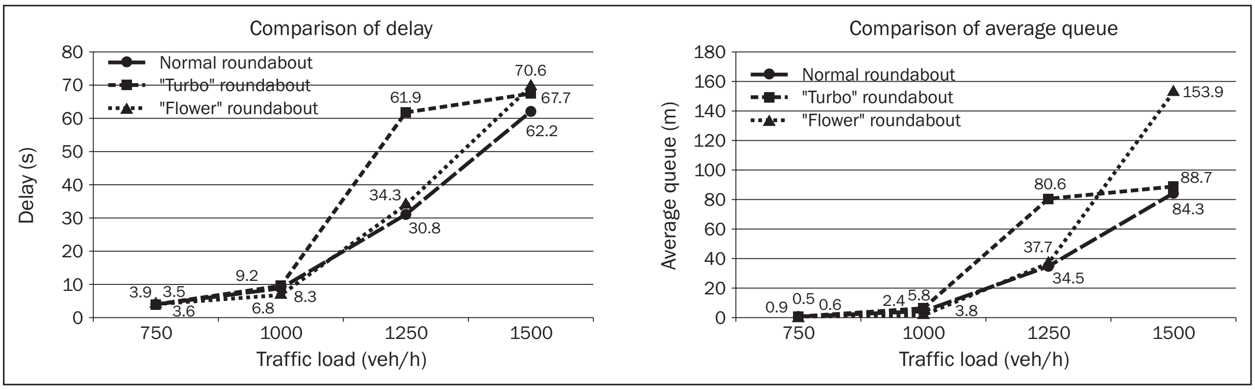

Figure 9 - Scenario with 60% of right-turners

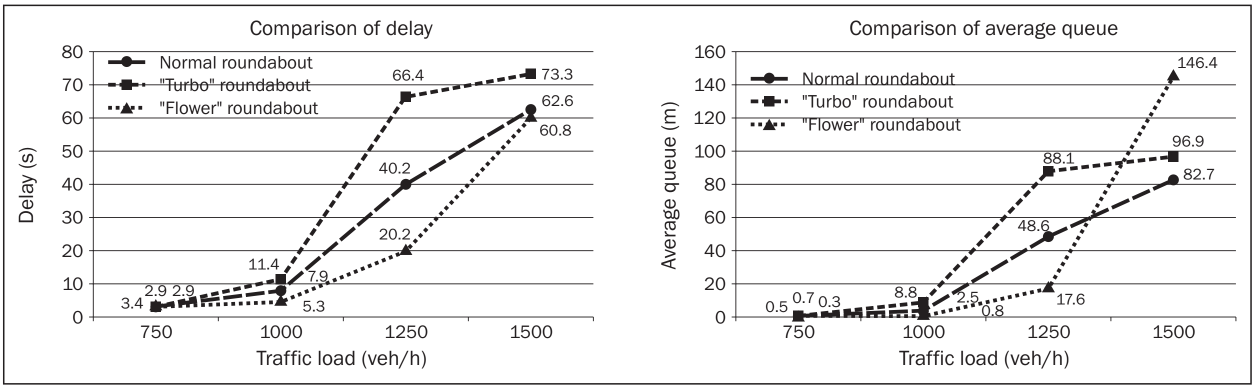

Figure 10 - Scenario with 80% of right-turners

4. CONCLUSION

The problem of poor traffic safety in the multi-lane roundabouts is resolved in several ways in different countries. However, the solution, whereby the number of conflict points is diminished has proven to be the most successful. The roundabout with the spiral course of the circulatory carriageway or the turbo roundabout is a type of roundabout which significantly diminishes the number of conflict points.

However, the turbo roundabout also has its deficiencies. The fact is that if a turbo roundabout is to be implemented instead of the existing two-lane roundabout, all the road curbs have to be torn down, the dividing islands and public lighting transposed..., which is financially extremely demanding. In addition, the turbo roundabout has conflict crossing points where the consequences of traffic accidents are the worst.

This paper introduces a new type of roundabout, the roundabout with "depressed" lanes for the right turning. This type of roundabout combines the positive characteristics of the "normal" two-lane roundabout and the "turbo" roundabout.

The flower roundabout turns out to be a good solution when dealing with high percentage of vehicles turning right. The bigger the percentage of right-turners, the more sensible is the use of the roundabout of this type.

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POVZETEK

NOVI TIP KROŽNEGA KRIŽIŠČA: KROŽNO KRIŽIŠČE S ”PRITISNJENIMI” PASOVI ZA DESNE ZAVIJALCE – ”FLOWER ROUNDABOUT”

V zadnjem času mnoge tuje prometno - varnostne analize kažejo na nizko raven prometne varnosti večpasovnih krožnih križišč. Ta problem v različnih državah rešujejo na različne načine, kot najuspešnejši pa se je pokazal način z zmanjševanjem števila konfliktnih točk (npr. turbo krožno križišče). Vendar ima tudi turbo krožno križišče svoje pomankljivosti: ima konfliktne točke križanja ter v primeru, da želimo izvesti turbo krožno križišče namesto obstoječega dvopasovnega križišča, je potrebna večja rekonstrukcija križišča.

V prispevku je predstavljen novi tip krožnega križišča - krožno križišče s "pristisnjenimi" pasovi za desno zavijanje. Glavna prednost takšnega tipa krožnega križišča je, da ga je možno izvesti znotraj meja obstoječega dvopasovnega krožišča. S stališča prometne varnosti ta tip krožnega križišča nima konfliktnih točk križanja.

KLJUČNE BESEDE

prometna varnost, krožno križišče, turbo krožno križišče, krožno križišče s »pritisnjenimi« pasovi za levo zavijanje

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