COMPARING TRAFFIC PERFORMANCES OF TURBO- ROUNABOUTS AND CONVENTIONAL ROUNDABOUT (CASE STUDY)

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ABSTRACT

Research conducted by Yperman and Immers in 2003 shows that the new geometry of these roundabouts, limits "wavelike-movements" and by convincing the driver to use a maximum of 2 lines, provides increasing capacity from 12 % to 20 % in the rotation (island) [4]. According to studies done on a especial case, by Lenin A.Bulla and William Castro, the results showed 7 % increase of capacity in Turbo-roundabouts in comparison with the typically roundabouts[5]. In terms of capacity, the results are not consensual. Some authors, using simplified approaches, concluded that turbo-roundabouts offer better capacity than conventional roundabouts of similar size. The application of a new lane-based method reveals that only in very specific scenarios that are uncommon in real-world networks can a standard turbo-roundabout be expected to provide more capacity than the equivalent two-lane roundabout.

Keywords: *traffic, turbo-roundabout, conventional roundabout*

INTRODUCTION

Roundabouts are often have high traffic volume. it requires a more complex design for easy passage of the traffic flow. In the current two-track vehicles crossing roundabouts, vehicle are forced to slow down according to a geometric curvature and size of the central island, which is one of the common problems related to driver behavior along the way passing. Due to transmission lines being apart, or lack of the use of signs for route selection, the possibility of lane-changing comes up, that the percentage of side-by-side encounters increase and reduce road safety [3].

In order to reduce these problems, a new concept called the Turbo-roundabout was introduced in the Netherlands in 1996 by lambertus Fortuijn, which often directional flows separated by physical separations.

For these reasons, drivers have to choose their own route before entering roundabouts, so the potential of collision reduce and safety of route goes up [4].

Compared to conventional schemes, the main advantages of a turbo roundabout are:

- limited number of potential conflict points among vehicular trajectories; (which you can see in Figure 1)
- slower speed along the ring;
- low risk of side-by-side accidents.

The main disadvantages are:

- presence of through conflict points in left-turning maneuvers (see Fig. 2);
- higher values of the critical gaps along the road, and left-turning maneuvers;
- generally lower capacity than conventional *double lane* roundabouts [5].

Figure 1. limited number of potential conflict points

Figure 2. Conflict points in left-turning maneuvers

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According to studies in terms of safety by Raffaele Mauro and Macro Cattani, the results appear to have great significance: in the different layouts and traffic conditions analyzed, turbo-roundabouts

provide reductions of the number of total potential accidents between 40% and 50%, and reductions of the number of potential accidents with injuries between 20% and 30%. The RSA developed a process that allowed concluding and ratifying the road safety benefits in turbo roundabouts. There was a 22% reduction found in overall risk assessment obtained by the comparison of the average risk of both intersection [5].

To evaluate and compare the performance of typically roundabouts with turbo-roundabouts parameters such as delay time, time travel, the length of the queue created in the entering and stop time is used. One major reason for this is the difficulty to model roundabouts using simulation software. Not many simulation software are flexible enough to allow the user to model roundabouts. VISSIM (is one of the few simulation software that can be used to model roundabouts. Compare two roundabout was in VISSIM , the turbo-roundabout layout is based on the two-lane roundabout geometry. In the first case the existing roundabout was simulated in software, which input and output volumes has been counted separately. Counting the number of vehicles done by 6 cameras, 4 of which was placed at the highest point of the surrounding buildings and 2 cameras were inside the roundabout. Cars counting time done from 12:00 noon to 13:00 pm for seven days that simulated volume is 7-day average was counted in each direction as shown in the following tables and figures.

Table 1- Entering Volume in Each Direction in Peak Hour

Entering Volume in Peak Hour	Flow direction
1106	Total incoming from North
483	Incoming (North to West)
158	Incoming (North to South)
461	Incoming (North to East)
1803	Total incoming from West
260	Incoming (West to South)
889	Incoming (West to East)
654	Incoming (West to North)
1482	Total incoming from South
140	Incoming (South to East)
397	Incoming (South to North)
945	Incoming (South to West)
1584	Total incoming from East
185	Incoming (East to North)
1009	Incoming (East to West)
390	Incoming (East to South)

Figure 3. Distribution Incoming Traffic from Each Direction of Roundabout to three other approaches (Percent)

In the next step, turbo-roundabout simulation was performed with taking into account the characteristics of the main roundabout, geometry and volumes of input and output for each direction, and the results are compared. Screenshot from Auto CAD layout for turbo-roundabout and conventional roundabout given in figures 4 and 5 respectively.

Figure 4. Turbo Roundabout

Figure 5. Conventional Roundabout

To optimize the results of software simulation, 10 repetition has been considered and results are the average of the replications.

Figure 6. Delay Measurements for Turbo and Conventional Roundabout

Figure 7. Travel Time Measurements for Turbo and Conventional Roundabout

Figure 8. Stopped Delay Measurements for Turbo and Conventional Roundabout

Figure 9. Queue Length Measurements for Turbo and Conventional Roundabout

Table 2. changes ratio

Comparison parameters	Changes ratio between turbo-roundabout and typically roundabout			
	West	East	North	South
Delay Time(s)	1.199	1.017	2.314	3.091
Vehicle Travel Time(s)	1.395	2.100	1.957	2.515
Stopped Delay(s)	0.959	0.888	2.417	3.033
Queue length(m)	1.140	1.245	0.548	1.450

CONCLUSIONS

Turbo-roundabout due to the channelization, not only reduce the number of collisions, but decrease side by side accidents as well. We have to pay attention to the fact that the improvement in the condition with the use of turbo-roundabout, is largely dependent upon the driving culture of the region [6].

According to the tables which mentioned before, with comparison between the turbo-roundabout indices and normal roundabout is observed that in most cases and in many directions turbo-roundabout is superior. So that, for the time delay in the West 19.9%, for East 1.7%, for North 131.4% and for south 209.1% Turbo is superior in comparison with normal roundabout. The reason for this, in the south side are the small crossing width, and existing the taxi station which can lead to a great deal of interference, which can be addressed with the use of turbo-roundabouts, and also movements can be avoided.

For the time travel in different directions, Turbo-roundabout has shown 39.5%, 95.7%, 110% and 151.5% reduction in the West, North, East and South respectively than normal roundabout which also, like the first case, due to reasons above, in the south direction we can have the most decrease in the travel time.

For the stop time use of turbo-roundabout instead of the typical roundabout shows, 4.1% increase in the West, 11.2% increase in the East, 141.7% reduction the north, and 203.3% reduction in the South regarding the stopping time, we have to consider the fact that with the increasing capacity more in the south and north directions compared to two other directions, and with making the travel of cars more convenient in these directions (south and north), the entrance of car into roundabout from east and west would be slower, and this will lead to a greater stopping time in the east and west directions of turbo-roundabout compared to normal ones.

As for the length of the queue created in Turbo-roundabout in comparison to normal roundabout in the North, 45.2% increase and in the West, East and South 14%, 24.5% and 45% has been reduced respectively. For the length of queue, as we expected, the most decrease is in the south direction, which is the most critical and the most crowded direction proportional to the number of entrance lines. However, the 42.5% increase in the north direction, considering the improvement of entrance condition from this direction to the roundabout shows that the performance of turbo-roundabouts is largely depend upon how we use it, and due to large volume of input from different directions into west, the length of queue in the roundabout, for the direct entrance to the roundabout has increased. As can be seen in the majority of cases compared, turbo-roundabout is superior, and in the south, the incoming traffic volume of which is high and number of entering line to roundabout is low, a significant improvement has been achieved. As a topic for future researches, we can compare fuel usage, and green-house gases emission in turbo-roundabouts and normal roundabouts, with the use of simulation soft wares like VISSIM.

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