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Distribution of the Roundabout Traffic

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ABSTRACT

The first roundabouts as traffic engineering facilities were not built until the beginning of the 20th century, although there were islands in the middle of the streets and marketplaces long before that time. Even in Roman times, people admired the water fountains and statues in marketplaces. A long time ago in England there were also traffic islands as pedestrian oases and in France there were also the imposing buildings in the middle of market squares. However, it was only the "planning border" of all these objects that turned them into traffic roundabouts.

1. Distribution of the roundabouts according to size

To (Hoffmann, 2010) the roundabouts are divided according to size or DTV – Average Daily Traffic Load[1] as follows (Fig.1):

- Tree circle (not traversable)
- Mini circle (traversable)
- Small KVP (KVP = individual roundabout places)
- Large KVP
- Multi-track KVP
- Turbo roundabout
- Multi-track KVP with LSA (traffic lights).

The efficiency of the individual roundabout places (KVP) depends essentially on the relation of the peak hour to the average daily traffic load as well as on the most even distribution possible of driving distances and circle diameters.

If the KVP is overloaded, bypasses can be used to increase performance. Two-lane KVP's have a 20 - 30% higher capacity than single-lane circulatory roadways. Turbo roundabouts (spiral form - traffic is guided from the inside to the outside) can also be arranged as special forms.

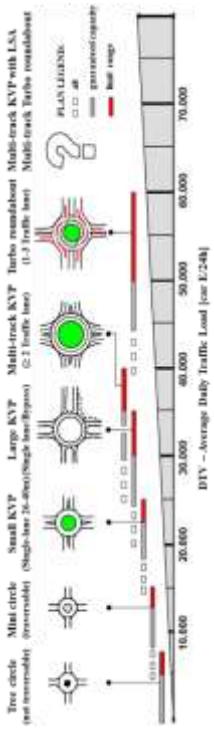

Figure 1. Distribution of roundabouts by size
Hoffmann, 2010

[1] DTV-average daily traffic load (traffic intensity) is the average number of car vehicles in the 24-hour period. The traffic load (traffic intensity) is the quotient of the number of vehicles N (traffic elements) and the time span T while the vehicles pass through the observation cross section. Units are e.g.: car/h, car E/24h, truck/24h etc. This is the important parameter for calculating performance and measuring the pavement.

Figure 2. Example for (One)Tree circle (not traversable): roundabout on the corner of Princess Road and Bruce Street in Nedlands, Western Australia
Wikimedia Commons, 2022

Figure 3. Example for (Three)Tree circle (not traversable): roundabout on the Schoerfling District Road L1265 in Upper Austria
Hrapović, 2020, prva knjiga

Figure 4. Mini roundabout with a passable central island in the author's place of residence Voecklabruck
Hrapović, 2020, prva knjiga

2. Distribution of roundabouts according to purpose

According to their purpose, the roundabouts are divided into (Univerza v Ljubljani, 2005):

1- Roundabouts that reduce traffic speed - these are planned in urban areas (in town) and in transition areas (between town and country).
2- Roundabouts that restrict traffic - these are provided in urban areas (inner cities) to limit traffic capacity by means of appropriate geometric elements.
3- Roundabouts allowing maximum traffic capacity under an acceptable level of safety - these facilities will be provided only outside urban areas (out of town).

3. Distribution of roundabouts according to the number of roundabout arms

According to the number of roundabout arms, the roundabout facilities are divided into:

1- Three-arm roundabouts (with three traffic arms) (Fig.5, Fig.6)
2- Four-arm roundabouts (with four traffic arms) (Fig.7, Fig.8, Fig.9)
3- Multi-arm roundabouts (with five or more traffic arms) (Fig.10, Fig.11).

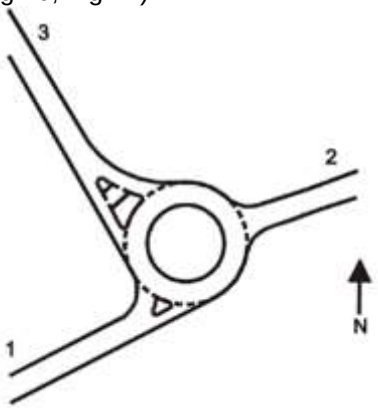

Figure 5. Three-arm roundabout (sketch)
Hrapović, 2020, prva knjiga

Figure 6. Example for a three-arm roundabout at the intersection of the Austrian national roads B38 /B127
Hrapović, 2020, druga knjiga

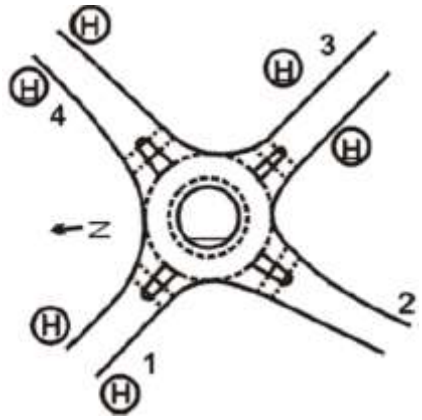

Figure 7. Four-arm roundabout (sketch)
Hrapović, 2020, prva knjiga

Figure 8. Example for a four-arm roundabout
Hrapović, 2020, prva knjiga

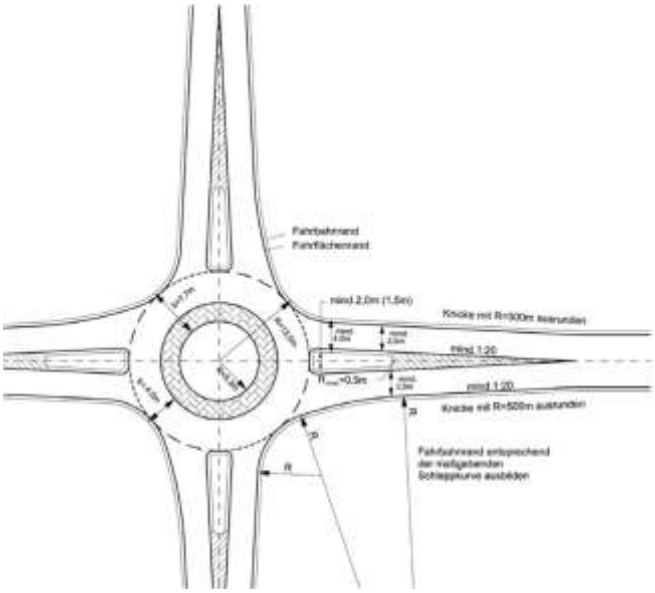

Figure 9. Example for a four-arm roundabout
Hessisches Landesamt, 2004

Fig.10 shows of a multi-arm roundabout (sketch) and Fig.11 shows a magnificent example of a multi-arm (and at the same time multi-lane) roundabout: the roundabout around "Arc de Triomphe" in Paris. It was my dream once in my life to drive around this world-famous roundabout with my own car, which I even succeeded in doing twice.

Sometimes it can happen that even unbelievable twelve vehicles drive side by side on this roundabout! In addition, the usual worldwide regulation that vehicles have priority on roundabouts does not apply, as vehicles that have just been given the green light through entrances equipped with traffic lights have priority.

To make sure that the chaos is perfect, there are traffic lights at every entrance and exit, which also regulate pedestrian traffic at the crossing points. After many futile and very dangerous attempts, with a lot of luck, I and my family in the car have finally managed to get out of this roundabout completely and safely!

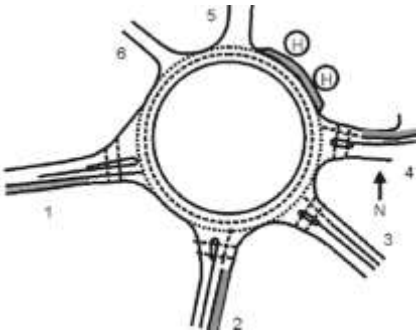

Figure 10. Five-arm (multi-arm) roundabout (sketch)
Hrapović, 2020, prva knjiga

Figure 11. The multi-arm and multi-lane "Arc de Triomphe" roundabout in Paris
Hrapović, 2020, prva knjiga

4. Distribution of roundabouts according to the number of traffic lanes

As mentioned at the beginning, a multi-lane roundabout is a roundabout with a multi-lane circular roadway and single or multi-lane entrances and exits. The number of lanes in the roundabout lane is used to divide the roundabout into several lanes:

1- Single-lane roundabouts (Fig.12)
2- Two-lane roundabouts (Fig.13, Fig.14)
3- Multi-lane roundabouts (Fig.11).

Small 1-lane roundabouts have an outer diameter of 26 to about 50 m and a fixed central island that cannot be driven over (Fig.12). The entrances and exits as well as the roundabout pavement are 1-lane. If the outer

diameter is small (e.g. < 30 m) and in builtup areas, it is advisable to install a truck apron with rough fastening (e.g. paving). This truck apron is used to accommodate the tractrix curve area for trucks and articulated buses. However, the crossing of the truck apron by cars should be prevented by a rough design or by a difference in height to the roundabout pavement (Hessisches Landesamt, 2004).

Figure 12. Example of a 1-lane roundabout
Hessisches Landesamt, 2004

Small 2-lane roundabouts have an outer diameter of 40 to 60 m and a central island that cannot be driven over. The roundabout pavement is 8 to 10 m wide, so that cars can drive next to each other, but not trucks and buses. There are no lanes marked on this small 2-lane roundabout pavement and it has no rough truck apron. The access roads can be 1 or 2-lane and the exits are always 1-lane (Hessisches Landesamt, 2004) (Fig.13).

The large 2-lane roundabouts have two marked lanes on the circular roadway (Fig.13).

Figure 13. A small 2-lane roundabout
Hessisches Landesamt, 2004

Figure 14. A large 2-lane roundabout
Kleine Zeitung, 2016

5. Roundabout in a traffic level with adjoining roads

If a roundabout is projected on a traffic level (at grade) with adjoining roads (roundabout arms), then there are basically two types of right-turn lanes (Hrapović, 2020, prva knjiga):
- Entrances and exits are directly connected to the circular roadway.
- Right-turning lanes are located outside the circular roadway (various types of bypasses) (Fig.15).

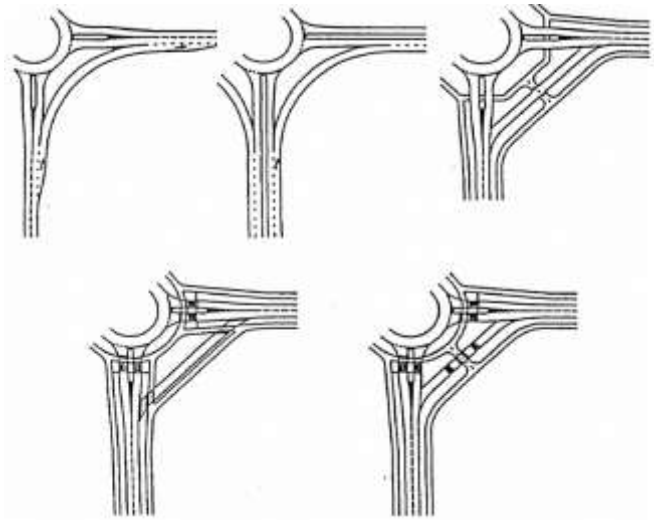

Figure 15. Right-turning lanes are located outside the roundabout pavement
Hrapović, 2020, prva knjiga

6. Roundabout in a traffic level with adjoining roads

If the roundabout is not located on a traffic level with adjoining roads, there are two types of such roundabouts:
- Designed as one large roundabout (Fig.16a, Fig.17)
- Designed as two smaller roundabouts ("dog bones") (Fig.16b, Fig.18).

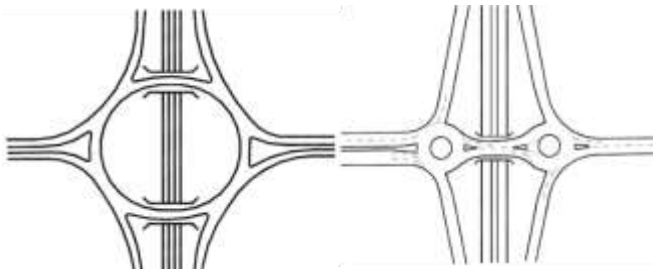

Figure 16. a) One large roundabout, b) two smaller roundabouts ("dog bones")
Hrapović, 2020, prva knjiga

A classic example of a large roundabout that is not located on a traffic level with connecting roads is the roundabout in the Czech Republic near Opatovice (Fig.17).

Figure 17. The large roundabout in the Czech Republic near
Hrapović, 2020, prva knjiga

There is another, special type of roundabout, where a road (usually the main road) passes through the tunnel (subway) below the roundabout (Fig.18).

Figure 18. Soell roundabout on the B 178 Loferer Strasse in Tyrolia
Hrapović, 2020, druga knjiga

The central island of this roundabout in beautiful Tyrol in Austria is really very splendidly equipped (Hrapović, 2020, druga knjiga) (Fig.19).

Figure 19. Beautiful Central Island of the Soell roundabout on the B 178 Loferer Straße in Tyrolia
Hrapović, 2020, druga knjiga

In two smaller roundabouts of the "dog bones" type near Ried im Innkreis (Fig.20), the B141 is linked to the B141a by directional exit and access ramps from the B141 to the underpassed B141a. Left-hand turning strips are arranged along these ramps. Due to the numerous left turns into the B141a Rieder Strasse Walchshausen junction, traffic backups occur on the exit ramps of the B141 Rieder Strasse.

The construction of roundabouts, which are connected to each other and thus represent the special form of "dog bones", has significantly increased the efficiency and traffic safety and reduced the waiting times for left-turners who want to turn from the ramps of the B141 into the B141a road, junction Walchshausen in Upper Austria (Amt der Oberoesterreichischen Landesregierung, 2016).

Figure 20. Two smaller roundabouts of the "dog bones" type near Ried im Innkreis
Hrapović, 2020, prva knjiga

7. Turbo roundabouts

The turbo roundabouts (Germ. "Turbokreisel") originally come from Holland, but have now become popular in other countries as well. The great advantage of turbo roundabouts is the low number of points of conflict and very high efficiency.

At single-lane roundabouts there are only 8 points of conflict (Fig.21), which are also easy for the driver to detect due to the geometric conditions. At the more efficient two-lane roundabouts, on the other hand, the number of conflict points doubles to 16 (Fig.21), which again increases the accident rates compared to the simple circle. In addition, the practical performance of the inner lane is only about 25 - 35% of that of the outer lane (due to the obstruction caused by traffic in the outer lane at intersections) (Hoffmann, 2010).

With the form of the turbo roundabout it is possible to build compact and efficient plants with a small number of points of conflict. Essentially, before entering the roundabout, the traffic flows are separated into right-turning and straight ahead drivers or straight ahead drivers and left-turning drivers. While the former drive directly on the outer roundabout pavement, the latter are spiraled from the inside to the outside.

With 10 points of conflict, the turbo roundabout shown here has a significantly more friction-free traffic flow than a comparable two-lane roundabout (Fig.21) and thus has an efficiency of the inner lane of about 50 to 80% of the outer lane. A limiting factor is that and it usually takes a while for users to understand the traffic relations (Hoffmann, 2010).

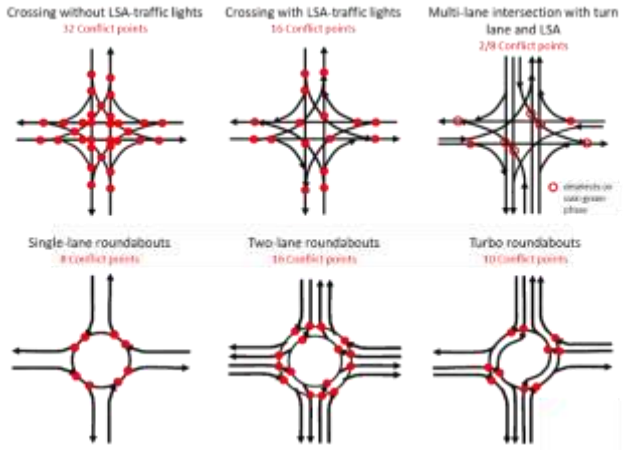

Figure 21. Beautiful Central Island of the Soell roundabout on the B 178 Loferer Straße in Tyrolia
Hoffmann & Zotter, 2011

The digital model of a so-called turbo tondes (this is the name of the turbo roundabout in Holland) can be seen on fig.22.

Figure 22. Digital model of a so-called turbo tondes
Hrapović, 2020, prva knjiga

Fig.23 shows what a turbo roundabout in Austria in the village of Bruck on the Grossglockner Strasse in Austria actually looks like.

Figure 23. Turbo roundabout in Austria in the town of Bruck on the Grossglockner Strasse in Austria
Hrapović, 2020, prva knjiga

8. Conclusion

Efficient infrastructure is one of the most important challenges facing modern cities and metropolitan areas. Roundabouts are becoming increasingly important and are being used more and more frequently because they offer performance, traffic safety and flexibility. In many cases, roundabouts are cheaper to build and have a higher capacity. In addition, the number of conflict points, which have a significant influence on traffic safety, is significantly lower than at intersections. Cars pass through a roundabout smoothly and they organize themselves independently through visual communication.

Moreover, a roundabout acts as a speed brake because the speed driven is 15 to 30 km/h and the driver has an overview. And even if there is an accident, the damages are usually smaller and remain at fender benders. Due to the continuous flow of traffic, noise and pollutant emissions are also lower. However, a disadvantage of roundabouts is that when there is a strong flow from one direction, vehicles of the adjacent flow cannot enter the roundabout, resulting in considerable waiting times.

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