



Hands on Sustainable Mobility

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Determining the Impact of different Traffic Regulations at Two-Lane Roundabouts on Capacity using Microscopic Traffic Simulation

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Introduction

Within the last two decades roundabouts got more and more popular with authorities and planners in Germany. (Hartz 1995) Also roundabouts experience a high level of acceptance from the road users as well. (Brilon and Geppert 2014) Constructing an intersection as a roundabout brings a lot of advantages regarding traffic safety, level of service, economic aspects and of course environmental aspects. (Brilon and Geppert 2014)

Single-lane roundabouts are familiar to German road users in the meantime. On the contrary two-lane roundabouts are the exception at the present, so road users seem to be overstrained using them. (Brilon and Geppert 2014) In other European countries even roundabouts with more than two lanes are frequently encountered. But traffic regulations in the various European countries differ considerably. While due to the current state of knowledge two-lane roundabouts show an approximately 30 % higher capacity compared to single-lane roundabouts (Forschungsgesellschaft für Straßen- und Verkehrswesen 2006; Brilon and Wu 2008), the impact of certain traffic regulations on capacity hasn't been examined yet.

Research Approach

Regarding an expected upcoming mixture of autonomous driving (maybe driverless) vehicles and conventional driven vehicles there is a need to examine the impact of different traffic regulations at two-lane roundabouts on capacity. The aim is to make a recommendation for uniform traffic regulations therefore and to examine if they could be applied in other countries. This will solve problems in many ways.

First of all uniform traffic regulations at two-lane roundabouts will help drivers from abroad handle with local traffic behaviour. Further, car manufacturers dealing with autonomous driving will get instructions on how their cars have to behave at two-lane roundabouts. Therefore they can find solutions to implement into their software. At last, if other traffic regulations will show higher capacities on two-lane roundabouts, these types of intersection may replace some signal-controlled intersections. This will serve economic and environmental aspects as well.

Besides finding uniform regulations for two-lane roundabouts it is the aim of the author to improve existing calculation methods as well as microscopic traffic simulation.

Traffic Regulations in Germany

German road traffic regulations (StVO) at two-lane roundabouts are very vague. In general drivers have to use the right lane on German roads, except the traffic density justifies a deviation. Vehicles with a total weight lower than 3.5 t are allowed to choose the lane freely on urban roads. There are no additional regulations for using a specific lane in a roundabout. The only rule is, that vehicles in the approach have to give priority to vehicles on the circular lanes. (Bundesministerium der Justiz und für Verbraucherschutz 2013)

Besides the regulations of the StVO there are driving tips provided by the General German Automobile Club 'ADAC'. The following behaviour is recommended: *“Select the right lane of the approach if you want to leave the roundabout at the first or second exit. For all further exits, select the left lane in the approach. If you are unsure, you should use the right lane.”* (ADAC - Allgemeiner Deutscher Automobil-Club e.V., Ressort Verkehr 2014)

The recommended driving behaviour is shown in Figure 1.

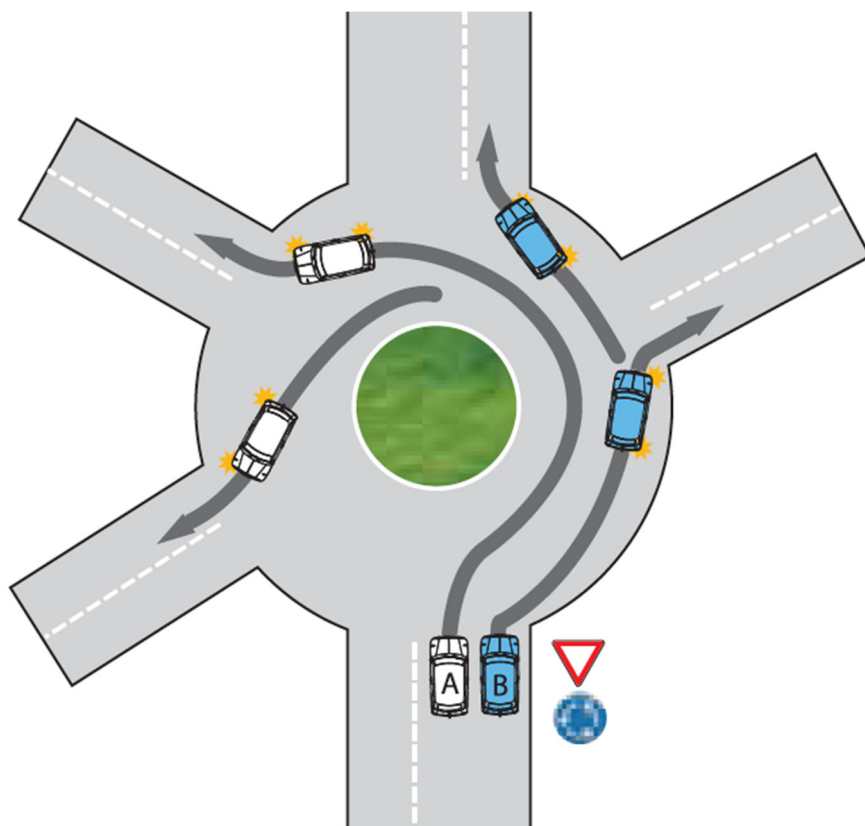


Figure 1: Recommended driving behaviour at two-lane roundabouts (ADAC - Allgemeiner Deutscher Automobil-Club e.V., Ressort Verkehr 2014)

Traffic regulations in other (European) countries

As already mentioned, traffic regulations differ in foreign countries. While France has very similar traffic regulations as Germany, the UK and especially Portugal have solid and very distinctive rules. At this point only the Portuguese traffic regulations are considered. The Portuguese traffic regulations are written down in the 'Código da Estrada', which says:

“When leaving the roundabout at the first exit, the driver must keep to the right.

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When leaving the roundabout via any of the other exits, the driver must use the right lane after passing the exit immediately before the exit he wishes to leave the roundabout via. He gradually approaches this exit and changes lanes after taking the appropriate precautions.

Drivers of animal-drawn vehicles, bicycles and trucks are permitted to use the right-hand lane throughout, but must make the exit accessible to other road users." (Autoridade Nacional Seguranca Rodoviaria n.d.)

The recommended driving behaviour is shown in Figure 2.

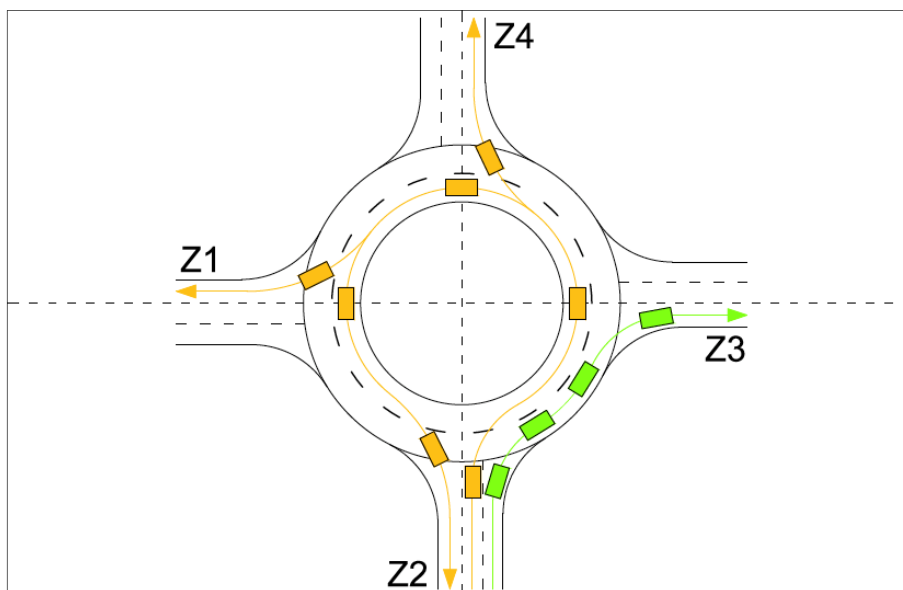


Figure 2: schematic representation of the Portuguese rules (Wachsmann 2016)

Due to the Portuguese rules the occupancy of lanes on the approaches as well as on the circular lane change significantly compared to the German traffic regulations. It is expected that this will lead to an effect on capacity. However this effect can not be quantified at the current status of work.

Juxtaposition of potential conflict points

Depending on the described traffic regulations there is also a change in numbers of potential conflict points. The potential conflict points between vehicles within a two-lane roundabout decrease from five conflict points considering the German traffic regulations (driving tips of the 'ADAC') to only one conflict point considering the Portuguese traffic rules, see Figure 3 and Figure 4. Less conflict points means less interaction between road users. This may also lead to an improved traffic flow and a positive effect on capacity.

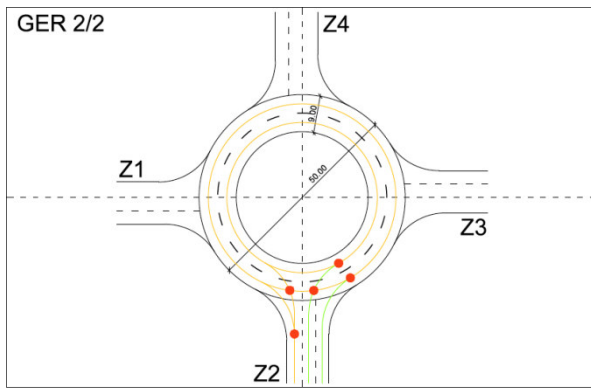


Figure 3: potential conflict points within a two-lane roundabout considering the German traffic regulations (Wachsmann 2016)

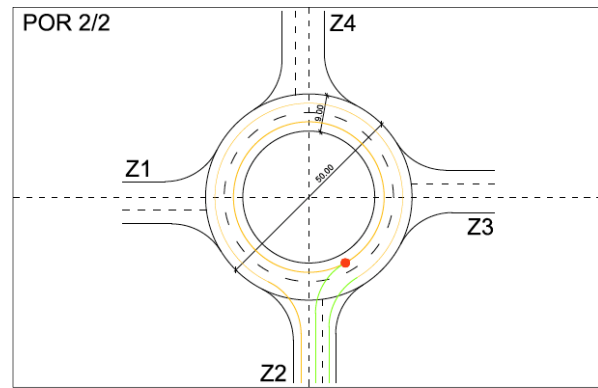


Figure 4: potential conflict points within a two-lane roundabout considering the Portuguese traffic rules (Wachsmann 2016)

Tools

The operations on two-lane roundabouts seem rather complex. A lot of mutual influences make it difficult to calculate capacity analytical. So common calculation methods for two-lane roundabouts mostly depend on empirical regression (Forschungsgesellschaft für Straßen- und Verkehrswesen 2015; Transport Research Board (Hrsg.) 2016). But a deep impact for this empirical analysis is local driving behaviour, which differs strongly between countries (Brilon 1988) and is deep embedded in the particular equations.

A common tool to get a grip on examining complex traffic situations is using microscopic traffic simulation software. Within these simulation models driver-vehicle units are considered. This means single units are simulated by modelling individual longitudinal and transverse behaviour. These single units move within a created network. Versatile results are generated from which conclusions on e. g. capacity can be drawn. But at this point, the software still has operational limits.

Conclusion and Outlook

In various (European) countries, different traffic regulations apply to multi-lane roundabouts. Their application has an impact on the distribution of traffic flows within the intersection, so it is likely that differences in capacity will arise. Microsimulation will be used to find answers to this question within the next two years

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