German roundabout design

ViaStrada Quality Assurance Statement	
This document has been prepared by ViaStrada Ltd for the benefit of the Australasian transport industry. It is based primarily on our interpretation of German guidance and professional experience with roundabout design in New Zealand and Australia. Roundabout design is very complex, and the concepts presented here must be carefully considered in light of the context of each specific site where a roundabout is to be designed. No liability is accepted by ViaStrada Ltd, or any of its employees, with respect to its use by any party.	
Prepared by: Megan Fowler	Reviewed by: Axel Wilke
Version 01: for availability by internet	5 Jul 2016
Version 02: add references; copy edit; definition of R_i, Appendix 1	19 Aug 2016

1. Introduction

This memo discusses the German approach to designing roundabouts that can be deemed 'cycle-friendly'. The information presented here builds largely upon the German guidance for roundabout design (FGSV, 2006), for which no official English translation is available. ViaStrada, with support from Abley Transportation Consultants, have applied this to the New Zealand context. This memo should be considered in conjunction with content on ViaStrada's website.[2]

2. Radial and tangential roundabouts

The roundabout illustrated on the left side of Figure 1 is a radial roundabout (figure adopted from Herland and Helmers, 2002). This is a European design concept that can achieve equitable negotiation speeds between motor vehicles and people cycling by ensuring drivers enter the roundabout through a deliberate turn. Whilst the approach may be straight and therefore physically conducive to high speeds, it appears like that of a T intersection and may have limited visibility to circulating traffic therefore drivers will approach the roundabout slowly, expecting a sharp turn into the roundabout and maybe having to give way. Compare this with the tangential roundabout design (illustrated on

[1] https://creativecommons.org/licenses/by/4.0/
[2] http://viastrada.nz/safe-rdbt

the right side of the diagram below) which is commonly used in most English-speaking countries, including New Zealand. Tangential roundabouts involve angled entries to roundabouts and therefore higher entry speeds are possible, especially where ample visibility is provided (Herland & Helmers, 2002).

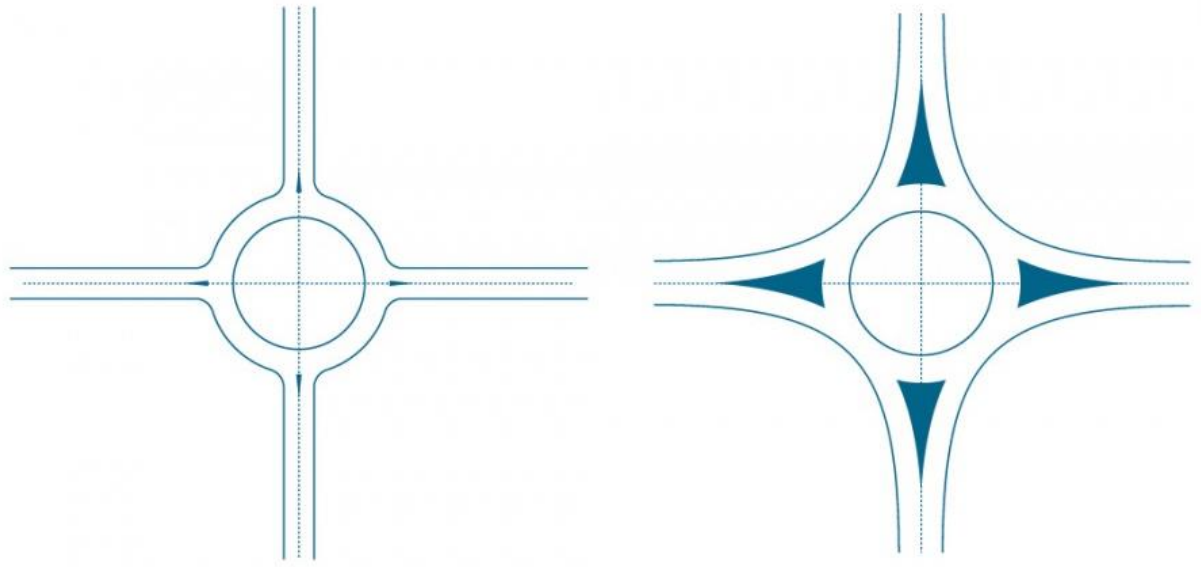

Figure 1: Radial design (left) and tangential design (right)

Continental European practice focuses on safety and hence the radial design, which results in lower speeds, is typically the preferred roundabout design. Lowering speeds improves safety for all roundabout users. In English-speaking countries, a stronger emphasis is placed on capacity and hence the typical roundabout design is tangential, as outlined in Patterson (2010). The radial design concept receives only cursory mention in Austroads guidance (Austroads 2015)[3] and designers who want to pursue this concept are encouraged to inspect continental European guidelines.

3. German guidance to roundabout design

There is a vast wealth of European guidance relating to radial roundabout design generally not provided in the English language. By way of example, the following description is from the German roundabout design guidelines (FGSV, 2006).

The German guidelines differentiate between four types of roundabouts:

1. mini roundabouts,
2. compact roundabouts,
3. compact roundabouts with multi-lane elements, and
4. signalised roundabouts.

[3] Note that the word "radial" does not appear in the December 2015 edition of *Guide to Road Design Part 4B: Roundabouts*

The compact roundabouts are to be of radial type[4]. Compact roundabouts come with different design parameters depending on whether the site is urban or rural.

Note that FGSV (2006) is the general guideline for roundabout design in Germany; it is not a guideline written specifically about designing roundabouts for cycling. But, because of the elements included in the guide, all the roundabouts designed according to this guide are inherently 'cycle-friendly', as well as being safe for other modes.

3.1 Mini roundabouts

Mini roundabouts as per the FGSV (2006) specifications are suitable for urban areas only, whilst the other types can be used in both urban and rural settings, albeit with different design parameters to reflect different speed environments.

3.2 Compact roundabouts

The following description applies to compact urban radial roundabouts, with Figure 2 showing the various definitions; refer to Appendix 1 for a table of annotations. Compact radial roundabouts can be built for intersections with an average annual daily traffic (AADT) of up to 15,000 veh/day without needing to model intersection capacity.

Fundamental design criteria are that the approaches are as perpendicular to the circulating lanes as possible, and that drivers proceeding straight ahead undertake considerable turns. Compact radial roundabouts involve single lanes for entry, circulating and departure.

The inscribed circle diameter ICD should fall into a range from 30 to 35 m, with 26 m and 40 m being permissible extremes. The width of the drivable lane (i.e. including a mountable apron) should be between 4 m and 6 m; this should be kept tight to encourage vehicular cycling.

A semi-mountable apron of between 40 mm and 50 mm is used in urban roundabouts to accommodate the design vehicle. Note that it is uncommon in Germany for motorists to drive on the mountable apron unless they absolutely must do so. This is due to German regulation, which prohibits motorists from mounting the mountable apron unless the size of their vehicle makes it physically impossible to avoid this, and German enforcement which means motorists generally comply with this rule. Therefore, the mountable apron height prescribed in German guidance can be less than the 75 mm recommended in New Zealand.

Tracking design should use a slow negotiating speed and a design offset of 0.5 m. The semi-mountable apron and the circulating lane should both have a fall of about 2.5% towards the outside of the roundabout.

The centre of the island is to be put as close as possible to where the axis from the approach roads meet. The width of the entry lane W_e should be between 3.25 m and 3.75 m. The width of the exit lane W_x should be between 3.50 m and 4.00 m. It is preferred that the entry and exit curves both involve a single radius, but compound radius curves

[4] Note that legacy roundabouts can be found that no longer meet the current design guidelines; they can continue to be operated but new roundabouts all have to comply with the current guidelines.

can be used to make allowance for vehicle tracking. The entry radius R_e should be between 10 m and 14 m. The exit radius R_x should be between 12 m and 16 m.

The axis of the splitter island should be perpendicular to the circulating lane, with a minimum width of 1.6 m. If the splitter island is to be used by pedestrians, its minimum width is 2.0 m. If the splitter island is to be used by people on bikes, its minimum width is 2.5 m. The two kerb edges of the splitter island are to be mostly parallel, but should follow the entry and exit radii near the circulating lane.

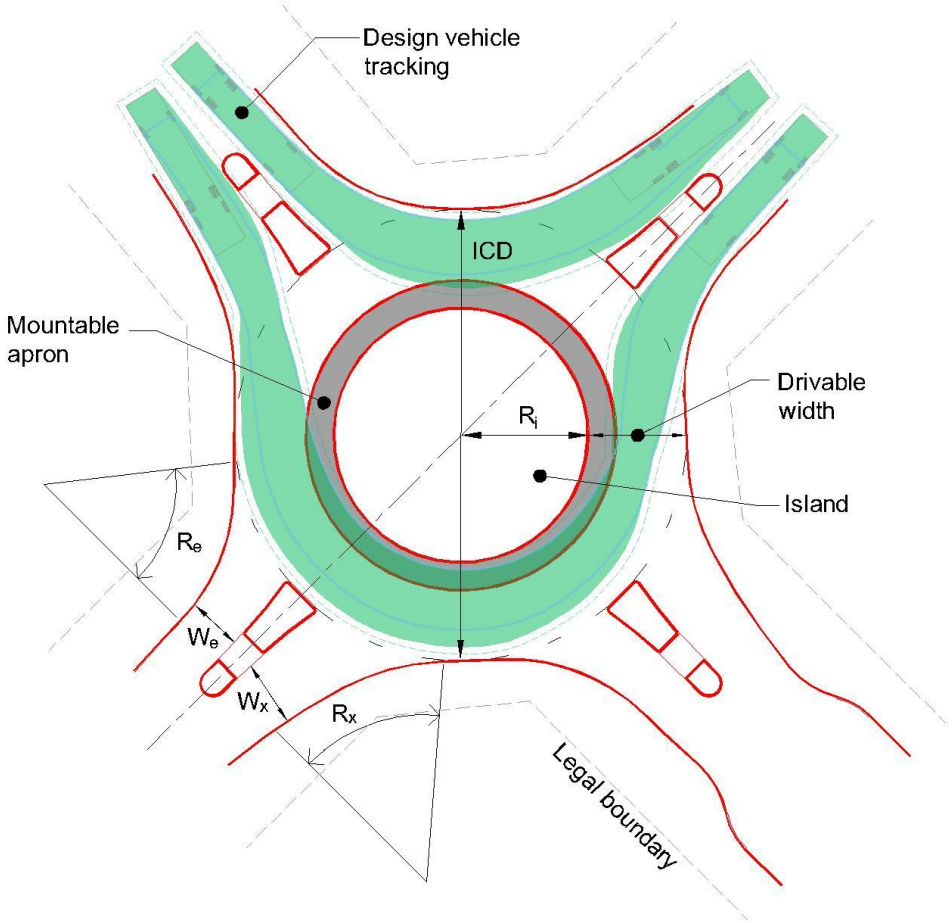

Figure 2: Definitions for German radial roundabout[5]

The specific provisions for people on bikes at compact radial roundabouts include the requirement that cycle lanes on the approach to a roundabout are to be terminated at least 10 m prior to the splitter island. It is stated that compact radial roundabouts (of the design described here) are safe for cycling for intersection volumes up to 15,000 AADT; beyond that, a circulating pathway for cycling should be provided. Such pathways should ideally be uni-directional, as that will be much safer than bi-directional operation. Where a pathway crosses a roundabout leg, the offset to the circulating lanes should be between 4 m and 5 m. If a pedestrian crossing is parallel to the cycling crossing, this should be placed directly adjacent to the cycling crossing on the side away from the circulating lane. Normally, a cycling crossing has priority, but it can be laid out so that people on bikes give

[5] Also refer to Appendix 1

way to other traffic. Where a cycle crossing is adjacent to a zebra crossing, priority must be given to the cycle crossing. Where bi-directional cycle traffic is permissible, there are certain signage and marking requirements at every crossing, and cycle traffic must always give way. Crossings can and should be highlighted by colour, or placed on a raised table.

Most of the design elements described here can be seen in the figure below, an urban roundabout serving an industrial area in Germany. As this concept is practically new to Australasia, the CAD file from which Figure 2 was produced is available on ViaStrada's website[6]. Road controlling authorities and consultants are welcome to download the file and use it for any purpose; the file is licensed as Creative Commons Attribution 4.0 International (CC BY 4.0)[7].

Figure 3: Compact radial roundabout, Bochum, Germany8

3.3 Compact roundabouts with multi-lane elements

Where capacity of a compact radial roundabout is exceeded, multi-lane elements may need to be considered, at which point cycling within the roundabout is not permitted. Where cycling needs to be accommodated, roundabouts of this nature must have a circular cycle path as a minimum treatment.

[6] http://viastrada.nz/safe-rdbt
[7] https://creativecommons.org/licenses/by/4.0/
[8] Source: https://commons.wikimedia.org/wiki/File:Bochum_-_An_der_Jahrhunderthalle-Wattenscheider_Straße_01_ies.jpg (photographer: Frank Vincentz; mirror image shown)

4. Conclusions

It is possible to design roundabouts in a way that is conducive to cycling. The German approach to radial roundabout design achieves lower speeds and limits the use of multiple lanes to minimise the number of potential conflict points. The encroachment areas on German roundabouts are designed to accommodate large vehicles whilst being unappealing for use by smaller vehicles.

5. References

Austroads (2015). Guide to Road Design Part 4B: Roundabouts. Sydney, Austroads.

FGSV (2006). *Merkblatt für die Anlage von Kreisverkehren*. Köln, Germany, Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV). [German roundabout guidelines; no English translation from original German version available]

Herland, L. & Helmers, G. 2002. *Roundabouts - Design and Function.* VTI Meddelanden, 58.

Patterson, F. *Cycling and roundabouts: An Australian perspective.* In: Bonham, J. & Lumb, P., eds. Australian Cycling Conference, 2010 Adelaide. Available: www.australiancyclingconference.org/images/proceedings/ACC-2010-Proceedings.pdf

Appendix 1

The following table shows the annotations used in the German guidelines (FGSV 2006) compared to this document:

Table 1: Annotations used

Design element	FGSV (2006)	ViaStrada document
Inscribed circle diameter	D	ICD
Entry radius	R_Z	R_e
Island radius[9]	$0.5*D_I$	R_i
Exit radius	R_A	R_x
Entry width	B_Z	W_e
Exit width	B_A	W_x

[9] Note that the German guide annotates island diameter instead.