Roundabout design guidelines and cycling safety

Amy Schramm, Narelle Haworth, Dick van den Dool, Justin Murphy, Xiaobo Qu & Mark McDonald

Asia-Pacific Cycle Congress, September 13-16

Centre for Accident Research & Road Safety - Queensland
Presentation Outline

• Project context
• Roundabout geometry
• Roundabout design guidelines
• Provisions for cyclists at roundabouts
• Overall safety
• Safety of cyclists at roundabouts
• Features that influence safety
• Cyclist perceptions of safety, behaviour
• Discussion
Context

• Review conducted as part of a Queensland Department of Transport and Main Roads funded project ‘Roundabout design review’

• The project examined:
  – Design guidelines
  – Factors that affect safety at roundabouts
Roundabout Geometric Features

Roundabout designs

• Approaches to roundabout designs differ
  – Motorist expectations
  – Cycling culture
  – Legislative frameworks

• Approach to roundabout designs can be condensed to 2
  – Tangential entries
  – Radial entries
Tangential vs Radial

**Tangential**
- Increased visibility on approach
- Greater vehicle speeds
- Increased traffic capacity

US, UK, Australia, NZ

**Radial**
- Decreased vehicle speeds
- Decreased traffic capacity

Germany, Sweden, Belgium, etc.

## Types of roundabouts

<table>
<thead>
<tr>
<th>Vehicle entry speeds</th>
<th>Designs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low [25 km/h]</td>
<td>Mini-roundabouts</td>
</tr>
<tr>
<td></td>
<td>Compact Urban (European design)</td>
</tr>
<tr>
<td>Moderate [35-40 km/h]</td>
<td>Urban single lane (Australian design)</td>
</tr>
<tr>
<td></td>
<td>Urban double lane</td>
</tr>
<tr>
<td></td>
<td>Rural single lane</td>
</tr>
<tr>
<td>High [50 km/h]</td>
<td>Rural double lane</td>
</tr>
</tbody>
</table>
Controlling vehicle speeds

- Vehicle speeds through roundabouts are controlled by:
  - Entry path radius: Australia, New Zealand
  - Radius of deflection: France
  - Deviation angle: Switzerland

- In the US, Australia, and New Zealand, speed is reduced by increasing the inscribed circle diameters.
## Comparison of single-lane designs

<table>
<thead>
<tr>
<th>Country</th>
<th>Operating speed</th>
<th>ICD</th>
<th>Central is. treatment</th>
<th>Splitter is.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>≤ 80 km/h*</td>
<td>26m – 54m</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>US</td>
<td>—</td>
<td>27m – 55m</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>UK</td>
<td>—</td>
<td>28m – 36m</td>
<td>Non-traversable†</td>
<td>No provisions</td>
</tr>
<tr>
<td>France</td>
<td>—</td>
<td>30m – 50m</td>
<td>Non-traversable</td>
<td>Provisions</td>
</tr>
<tr>
<td>Switzerland</td>
<td>—</td>
<td>26m – 40m</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>Italy (Lombardia)</td>
<td>—</td>
<td>26m – 50m</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>Italy (national)</td>
<td>Speed ↓ measures</td>
<td>25m – 50m</td>
<td>Non-traversable</td>
<td>No provisions</td>
</tr>
</tbody>
</table>

† Truck aprons provided if required
## Comparison of multi-lane designs

<table>
<thead>
<tr>
<th>Country</th>
<th># circ. Lanes</th>
<th>ICD</th>
<th>Central is. treatment</th>
<th>Splitter is.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>≥ # entry</td>
<td>34m – 62m</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>US</td>
<td>≥ # entry</td>
<td>46m – 91m</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>UK</td>
<td>≥ # entry</td>
<td>36m – 100m</td>
<td>Non-traversable†</td>
<td>No provisions</td>
</tr>
<tr>
<td>France</td>
<td>1 (no lane markings)</td>
<td>30m – 50m</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>Switzerland</td>
<td>—</td>
<td>—</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>Italy (Lombardia)</td>
<td>1-2</td>
<td>50m – 70m</td>
<td>Non-traversable†</td>
<td>Provisions</td>
</tr>
<tr>
<td>Italy (national)</td>
<td>1 (no lane markings)</td>
<td>25m – 50m</td>
<td>Non-traversable†</td>
<td>No provisions</td>
</tr>
</tbody>
</table>

† Truck aprons provided if required
Provisions for cyclists

• Generally no special facilities for low-speed, single-lane roundabouts
• Bicycle lanes (on circulating roadway) permitted in:
  – UK, Australia [2]
• Greater off-road provisions at roundabouts for cyclists in continental Europe
• Bicycles prohibited from multi-lane roundabouts in Germany [3]
Safety for all users

- Overall crashes down by 36% [4]
- Fatal crashes down 66% and injury crashes down 46% [4]
- Modelling (UK and US) suggests replacing intersections with roundabout crashes [5-8]
- Less effective as black spot treatments [9]
- Roundabout complexity influences safety
  - Regardless of design approach, ↑ entry arms ↓ safety [5]
Safety for cyclists

• Cyclists are less safe at roundabouts than signalised intersections [10]
• Are less safe for all vulnerable road users
• The impact of roundabouts on safety differs across jurisdictions [11]
• Greatest risk from entering vehicles [Sakshaug]
• Difficult to make direct comparison
  – Traffic regulations (drivers yielding on exit)
  – Roundabout design approach
Design features that improve safety

• Small traffic calming roundabouts \[12\]
  – Also improved yielding behaviours at pedestrian crossings

• Single-lane roundabouts \[13\]
  – Where the central island radius $\geq 10m$

• Presence of bypass facilities \[13\]
  – Safest for all road users
Design features that reduce safety

- Older roundabouts (reflects design standard) [14]
- Large drive curve [14]
- Narrow aprons [14]
- Multi-lane roundabouts [13]
- Roundabouts with marked cycle lanes [15]
- High traffic volumes [14]
- High cyclist volumes [14]
Cyclist perceptions of roundabouts

- Perceptions differ between countries
- Riders in the UK and USA report feeling uncomfortable/unsafe riding through roundabouts [16, 17]
- Cyclists in Denmark more likely to only perceive risk at specific locations [18]
- Riders most apprehensive when vehicles enter [18]
Cyclist behaviours at roundabouts

- Cyclist positioning may influence safety
- Drivers’ gave more visual attention on cyclists when no bicycle facility was present [19]
- Majority “straight-line” when negotiating a roundabout, approximately 40% ride on the outer edge [20]
- Less than half travelled in circulating bicycle lanes [21]
Discussion

• Bicycle riders are not homogeneous
  – Ride for different reasons
  – Perception of risk is personal
• Roundabouts have overall benefit to road safety
• Cyclists do not receive same safety benefit
• On-road bicycle lanes appear to be more hazardous, for all road user groups
Acknowledgement

• Review conducted as part of a TMR-funded project ‘Roundabout design review’

• Contributed to development of Technical note 136 now published on TMR web site

Questions?

Amy Schramm

a.schramm@qut.edu.au
References


