Roundabouts: A State of the Art in Germany

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Traditional Roundabout

Muenster / Westfalia (built 1944 - 1950)
Traditional Roundabout

Munich
Typology of Roundabouts

Types according to
- ADT
- size
Mini Roundabout
Mini Roundabout

urban

construction cost: 10000 $

rural

(experiment)
Mini Roundabouts: Safety

Accident rates
[acc. / 1 Mio. veh.]

Before + After Study with 20 Mini-R-about

Accident cost rates
[€ / 1000 veh.]
Mini Roundabout

Characteristic design elements

- Only admitted for urban intersections
- Diameter: 13 - 24 m / 40 - 80 ft
- circle width: 4.5 - 6 m / 15 - 20 ft
- circle inclined with 2.5 % to the outside
- central apron with min. curb height: 3 cm = 1"
- single lane entries + exits
- no flaring of entries

- capacity < 20 000 veh./day
- entry + circulating flow < 1200 veh./h
Compact single-lane Roundabout
Compact single-lane Roundabout

1 lane for:
- entries
- circle
- exits
Compact single-lane Roundabout

Characteristic design elements

• urban and rural
• Diameter: 26 - 45 m / 85 - 150 ft
• circle width: 6 - 8 m / 20 - 27 ft
• circle inclined with 2.5 % to the outside
• central apron with min. curb height: 3 cm = 1"
  (only urban and with small diameter)
• single lane entries + exits
• no flaring of entries
• entries as vertical as possible
• capacity < 25 000 veh./day
Compact single-lane Roundabout

Characteristic design elements

• central apron
  with min. curb height: 3 cm = 1"
  (only urban and with small diameter)
Compact single-lane Roundabout

Main characteristics:

- safest type of all intersections
- capacity up to 25,000 veh. /day
Large trucks at roundabouts

AutoTurn
Safety at single-lane roundabouts

- Killed: -88%
- Severe injuries: -87%
- Slight injuries: -60%
- All accidents: -30%

No. of accidents

before | after (R-about)
Bypass lanes

Bypass = direct right turning lanes
Bypass lanes

Bypass = direct right turning lanes
Bypass lanes

Bypass = direct right turning lanes
Semi-2-lane Roundabout

- diameter: 45 - 60 m (150 - 200 ft)
- wide circle lane: 8-10 m (27 - 33 ft)
- no circular lane marking
- "vertical" entries
- 2-lane entries only where necessary
- only 1-lane exits
- no cyclists allowed on the circle

rural environment: Bad Aibling
Semi-2-lane Roundabout

- diameter: 45 - 60 m (150 - 200 ft)
- wide circle lane: 8-10 m (27 - 33 ft)
- no circular lane marking
- "vertical" entries
- 2-lane entries only where necessary
- only 1-lane exits
- no cyclists allowed on the circle

urban environment: Oberhausen
Semi-2-lane Roundabout

urban environment
Benefits of Roundabouts for:

- **motor vehicles**
  - cars
  - lower delays
  - higher safety

- **pedestrians**
  - no delays
  - higher safety
Disadvantages of R-about for:

- cyclists
  - higher risks

R = cyclist
Rather safe Cycle Design (I):

- **Cyclists on the circle**
  (urban + ADT < 15000 veh./d)

- disadvantage: several cyclists on the ped crossing (no risk)
Rather safe Cycle Design (I):

- **Cyclists on the circle**
  (urban + ADT < 15000 veh./d)

  Cycle path could be interrupted at the entrance to a R-about.
Rather safe Cycle Design ( II ):

Separate Cycle tracks
(rural + ADT > 10000 veh./d)

rural: no priority for cyclists

disadvantage: several cyclists going the wrong direction ( dangerous ! )
Rather safe Cycle Design (II):

Separate Cycle tracks
Rather safe Cycle Design (II):

- Separate Cycle tracks
Capacity of Roundabouts (Method)

\[ G = 3600 \cdot \left(1 - \frac{t_{\text{min}} \cdot q_k}{n_k \cdot 3600}\right)^{n_k} \cdot \frac{n_z}{t_f} \cdot \frac{q_k}{3600} \cdot \left(t_g - \frac{t_f}{2} - t_{\text{min}}\right) \]

- **G** = basic capacity of one entry [pcu/h]
- **q_c** = traffic volume on the circle [pcu/h]
- **n_k** = number of circulating lanes [-]
- **n_z** = number of entry lanes [-]
- **t_c** = critical gap [s]
- **t_f** = follow-up time [s]
- **t_{\text{min}}** = minimum gap between succeeding vehicles on the circle [s]

\[ G = A - B \cdot q_c \]

\[ G = C \cdot e^{-D \cdot q_c} \]

Current favorite

HBS = German HCM

Critical Gap Theory

Empirical Regression
Capacity of Roundabouts (Method)

2-lane circulating
2-lane entry
(4500 data points)

\[ G = C \cdot e^{-Dq_c} \]
Capacity of Roundabouts (Method)

\[ G = C \cdot e^{-Dq_c} \]

2-lane circulating
2-lane entry
Capacity of Roundabouts

Graph showing the capacity of roundabouts as a function of q-k [pcu/h]. The graph includes lines for different configurations, such as 2/2 large, 2/2 compact, 1/2, and 1/1.
Capacity of Roundabouts
Capacity of Roundabouts
Capacity of Roundabouts
Capacity of Roundabouts

Unused left entry lane
## Capacity of Roundabouts

**General applicability of roundabouts according to capacity**

<table>
<thead>
<tr>
<th>Lanes entry / circle :</th>
<th>1/1</th>
<th>compact 2/2</th>
<th>large 2/2</th>
<th>signalized 2/2</th>
</tr>
</thead>
<tbody>
<tr>
<td>can be applied without capacity calculations below $\rightarrow$</td>
<td>15 000</td>
<td>16 000</td>
<td>20 000</td>
<td></td>
</tr>
<tr>
<td>has a maximum capacity of $\rightarrow$</td>
<td>25 000</td>
<td>32 000</td>
<td>35 000 - 40 000</td>
<td>50 000 - 60 000</td>
</tr>
</tbody>
</table>

veh/d
Estimation of traffic performance: KREISEL

Computer program KREISEL

www.r-about.de
Other aspects

- **Roundabouts** are expected to reduce fuel consumption and emissions.
- **Roundabouts** reduce noise by 3 - 5 dB(A).
- **Roundabouts** cause lower investments and maintenance since they need no traffic light. Thus, they are usually economically favorable.
- **Roundabouts** are loved by the public, by the press, and by politicians.

- Many more Details
- see ADAC (=German AAA)  www.adac.de
Conclusions

- **single-lane roundabouts** are the safest type of all kinds of intersections
- design should be speed-reducing
- capacity is unexpectedly large - but limited
- single-lane roundabouts are a very favorable type of intersection under all possible aspects

- **larger roundabouts** are treated with care
- semi-2-lane can be recommended
- larger than the compact semi-2-lanes are **not** favored due to safety reasons
- 2-lane exits are banned
- cyclists are banned on multilane roundabouts

- **larger signalized roundabouts** can be a useful solution under rather specific circumstances
Thank you for your attention

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