Roundabouts :
A State of the Art in Germany

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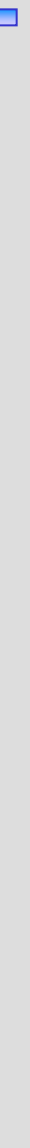
Lehrstuhl
für Verkehrswesen

Traditional Roundabout

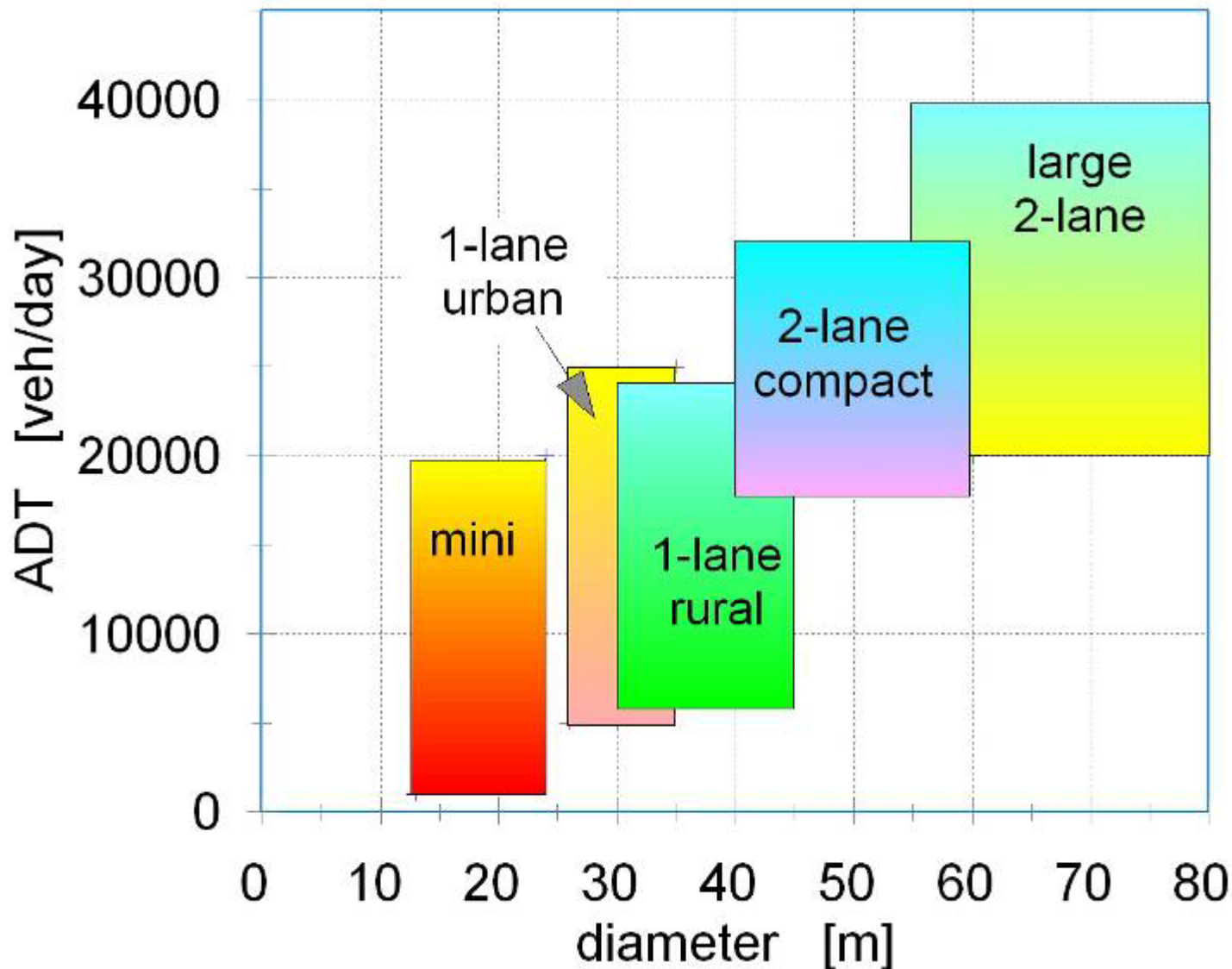**Muenster / Westfalia (built 1944 - 1950)**

Traditional Roundabout

Munich

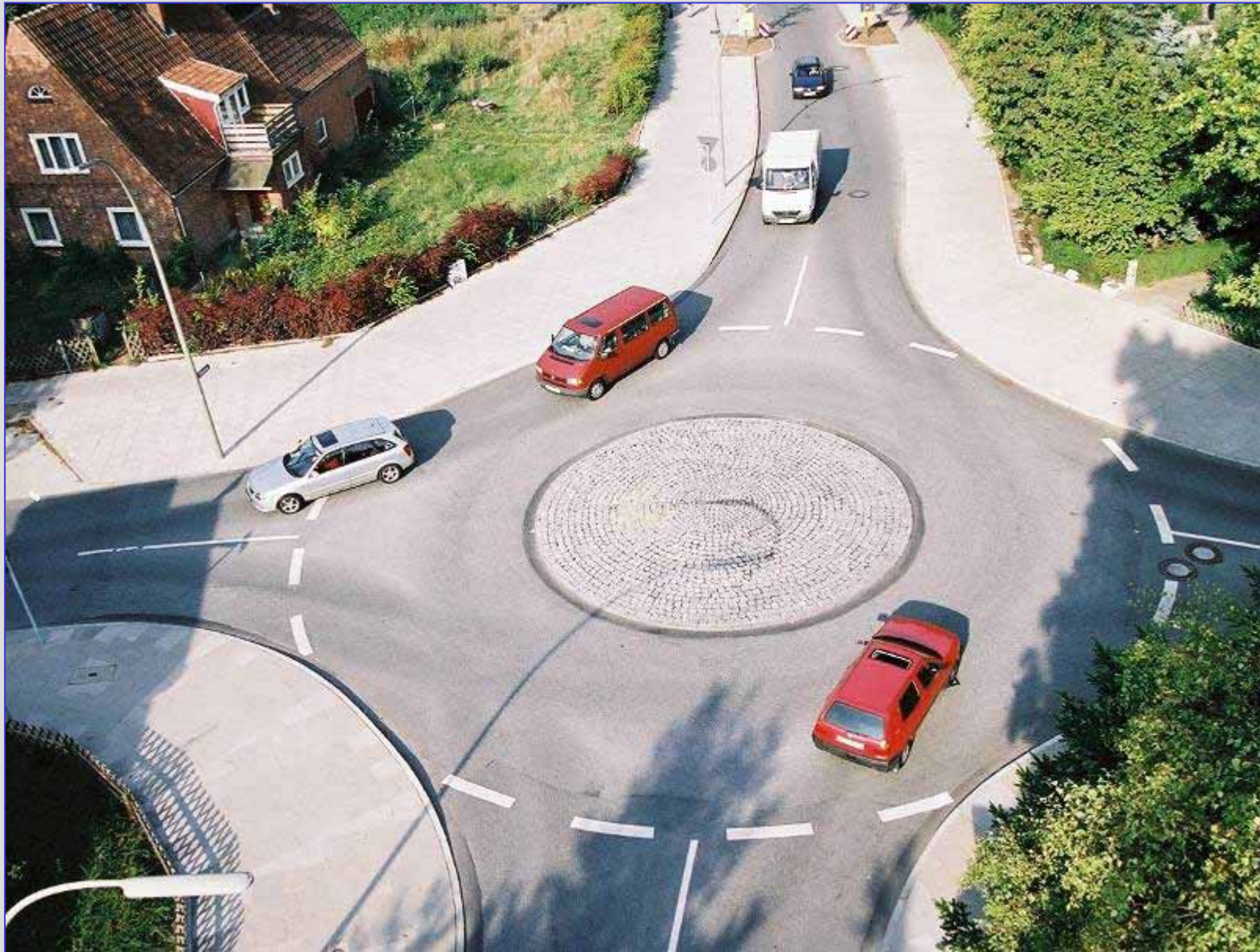# Typology of Roundabouts

Types according to

• ADT ↑

• size →

Mini Roundabout

Mini Roundabout

urban

construction cost:
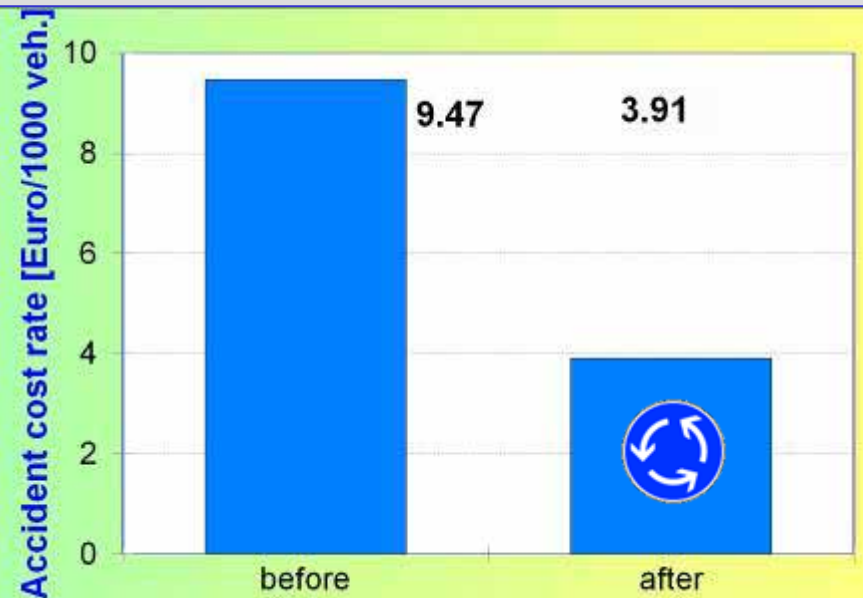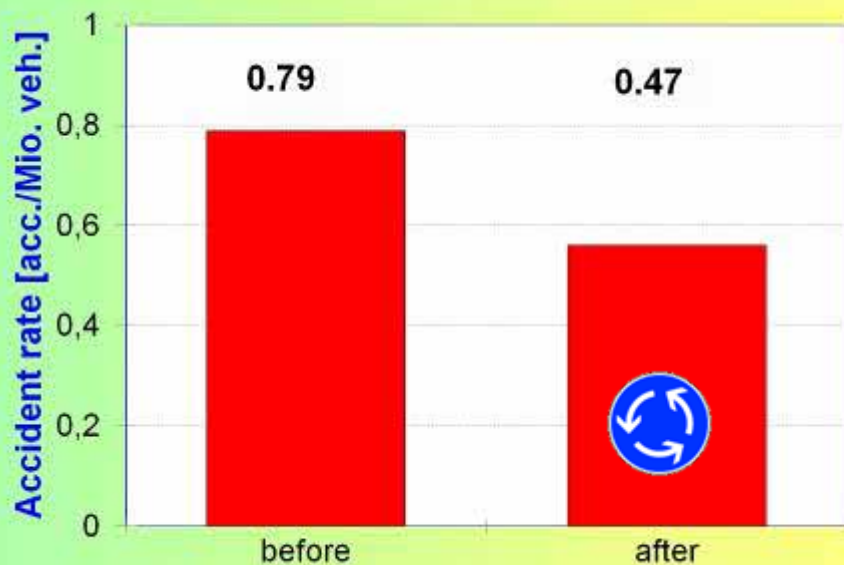10000 $

rural

(experiment)

Mini Roundabouts: Safety

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

Accident cost rates
                    [€/ 1000 veh.]

Before + After Study with 20 Mini-R-abouts

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
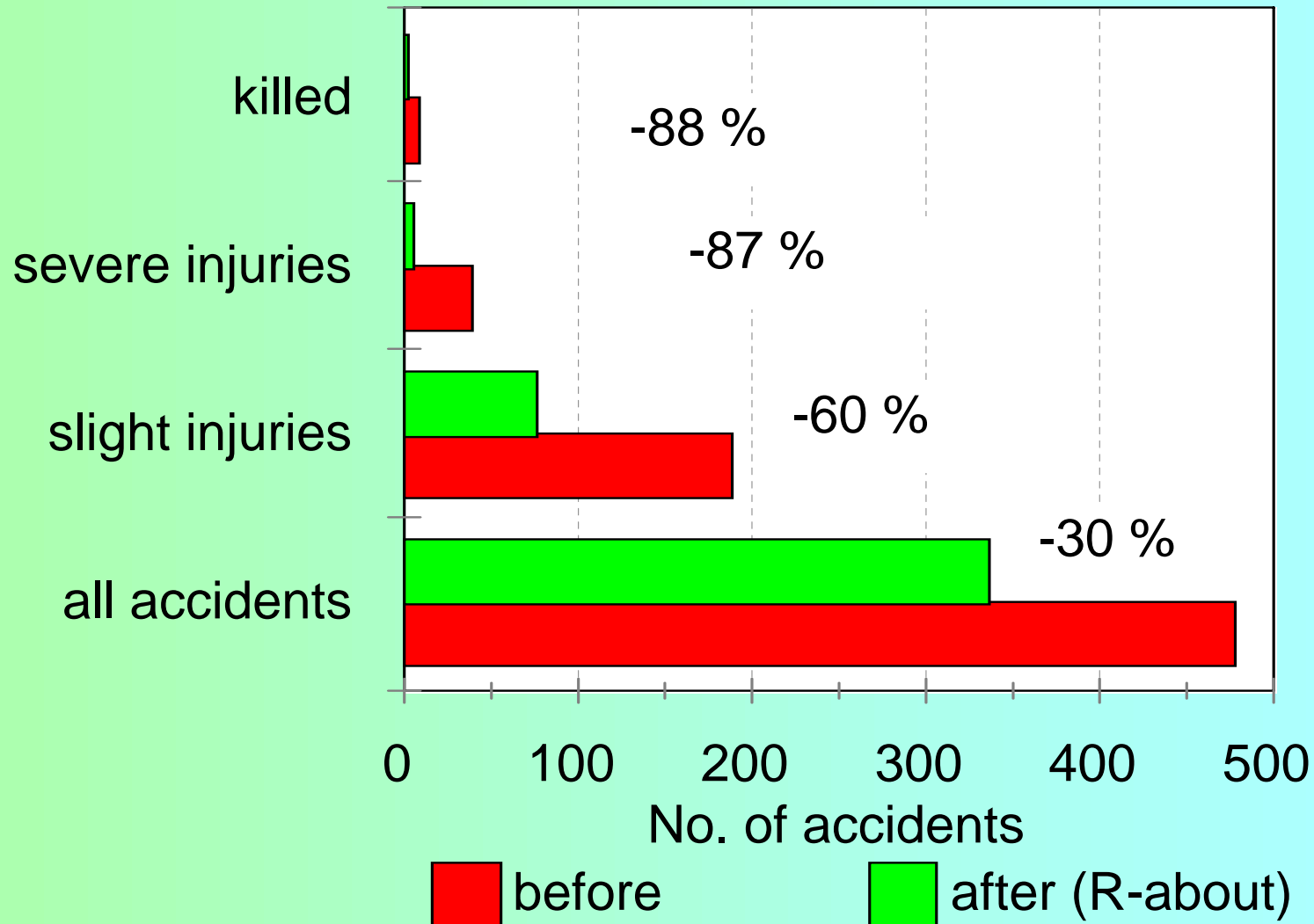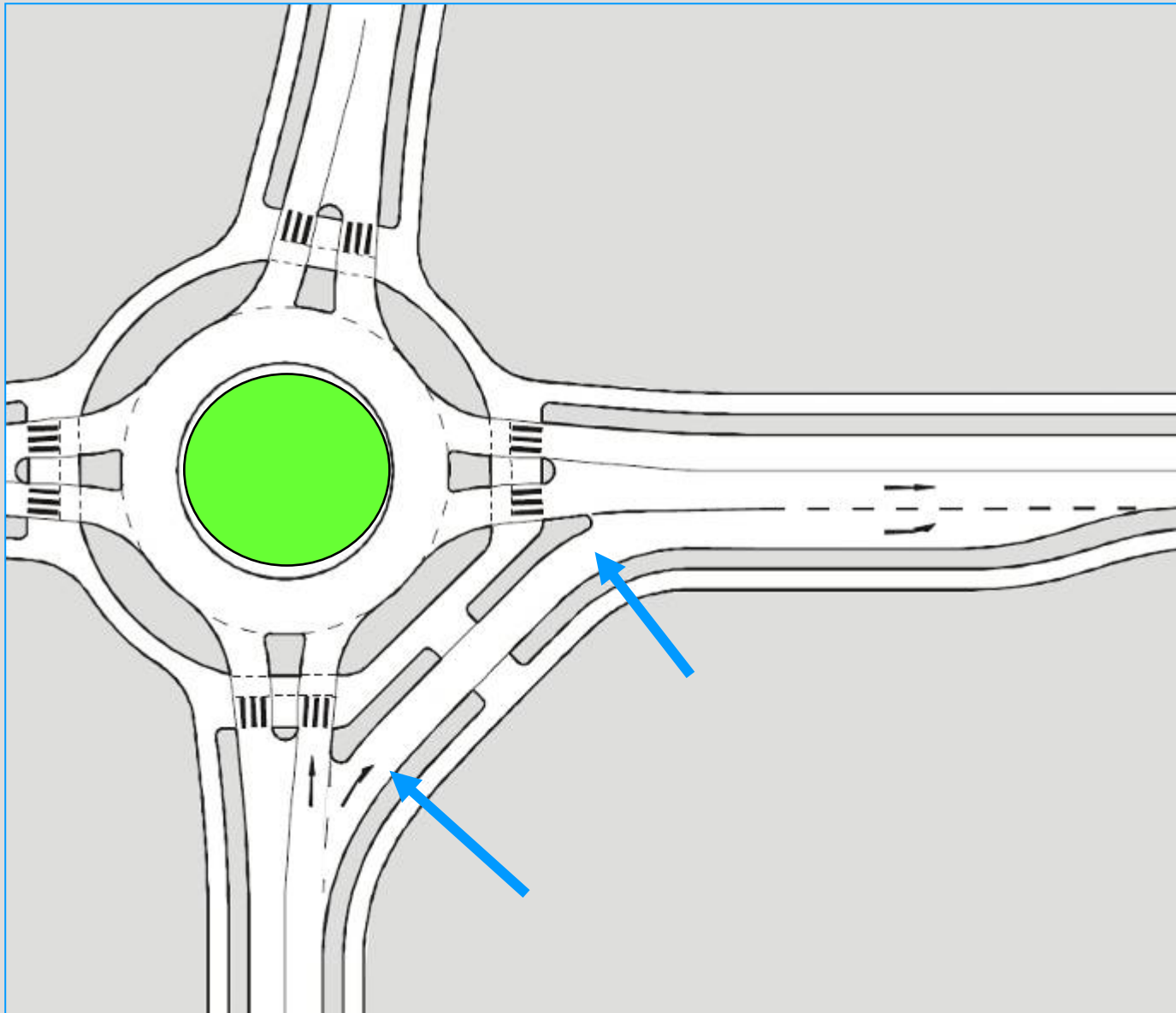- capacity up to 25 000 veh. /day

Large trucks at roundabouts

AutoTurn

Safety at single-lane roundabouts

Bypass lanes

Bypass = direct right turning lanes
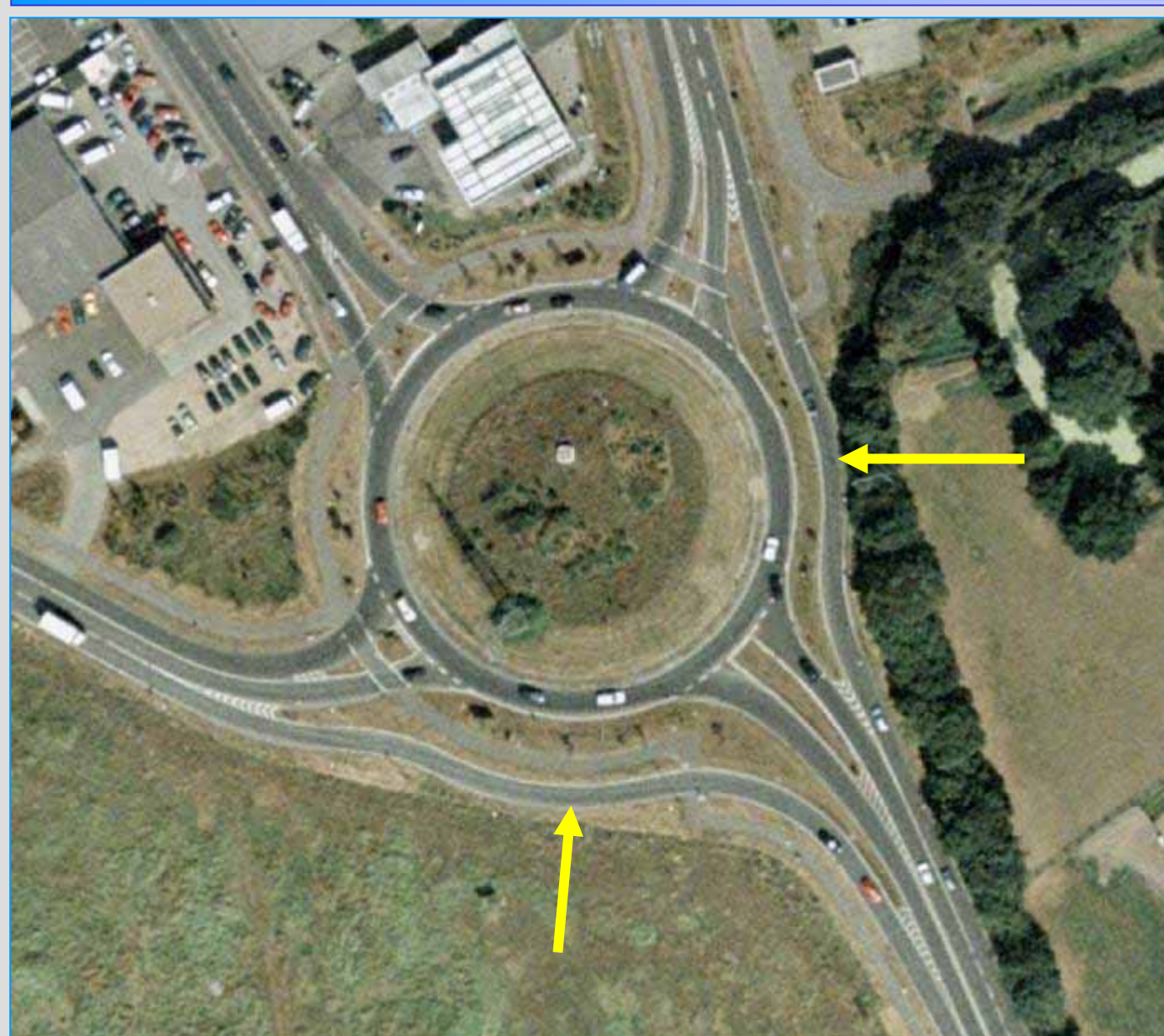
Bypass lanes

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**
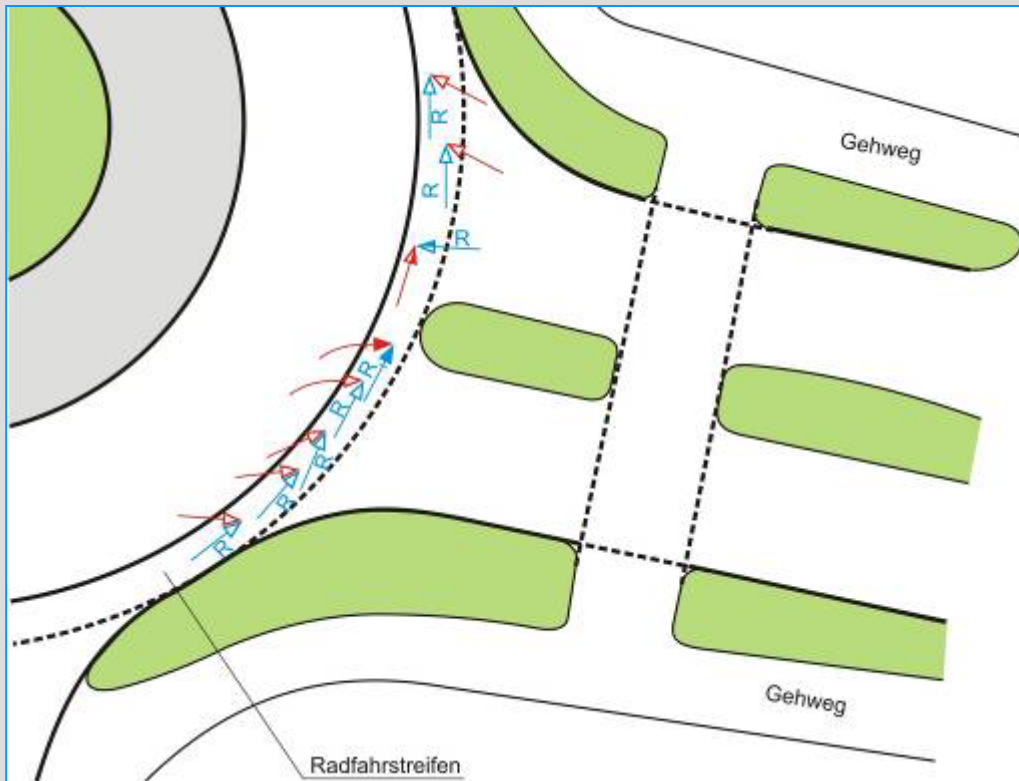 **- cars**

  - **lower delays**

  - **higher safety**

- **pedestrians**

  - **no delays**

  - **higher safety**

Disadvantages of R-abouts for :

- ## cyclists

  - **higher risks**

Gehweg

Gehweg

Radfahrstreifen

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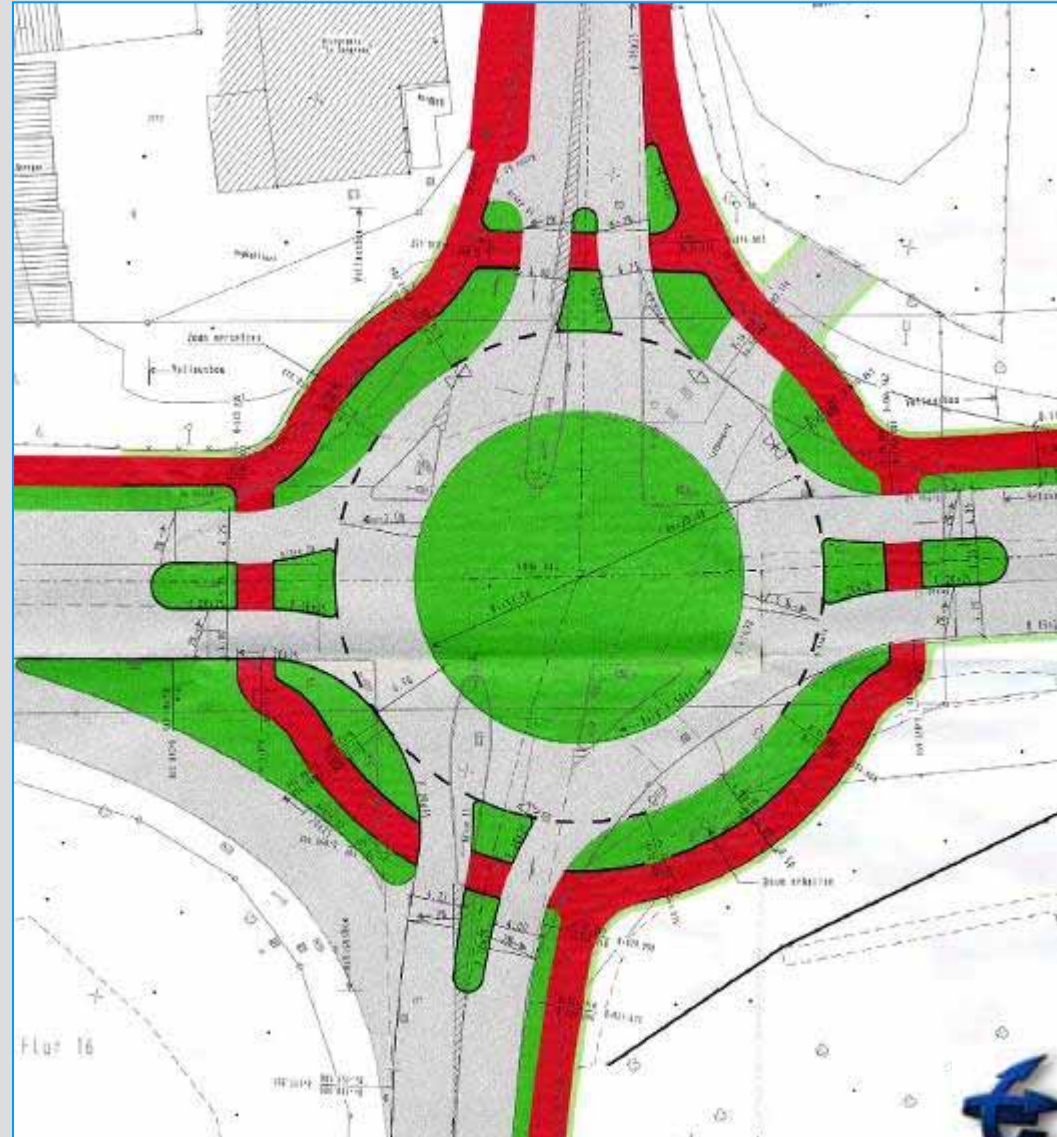## Cycle tracks
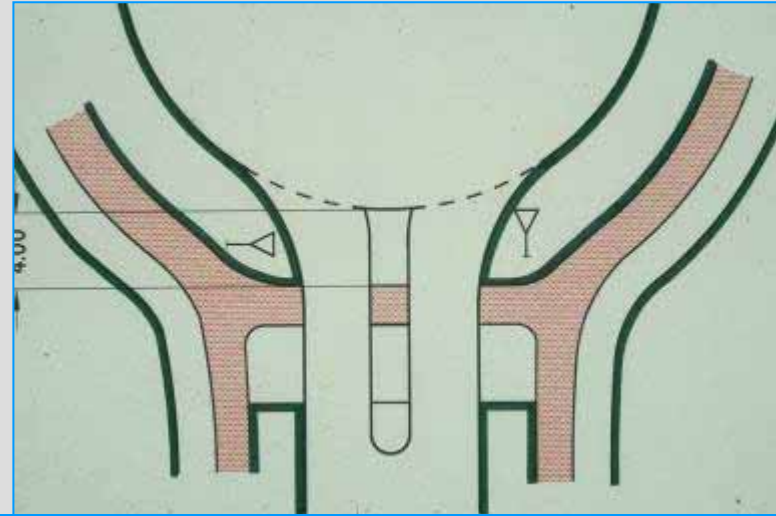
(rural + ADT > 10000 veh./d)

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)

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

Critical Gap Theory

HBS = German HCM

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_{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

Empirical Regression

Capacity of Roundabouts (Method)
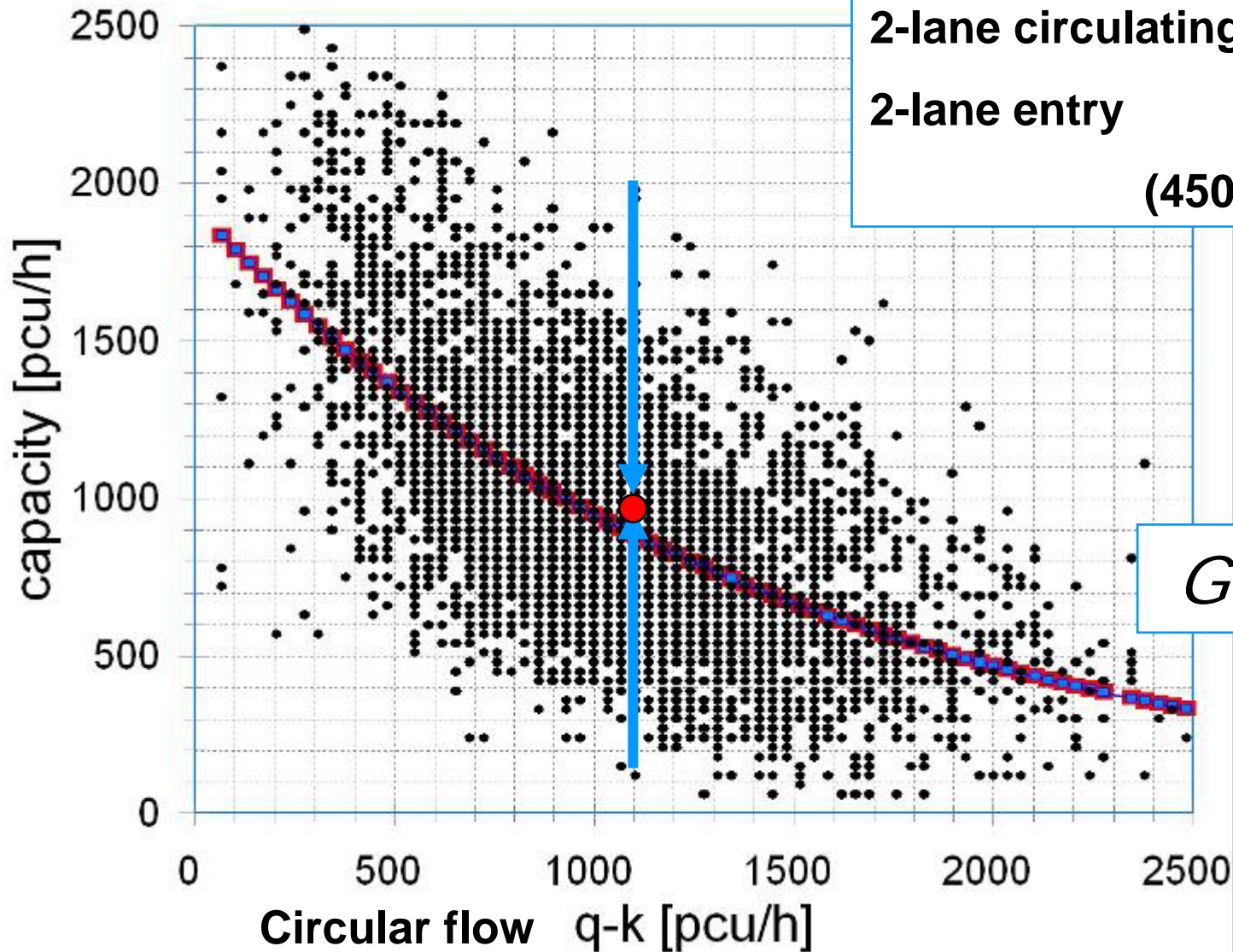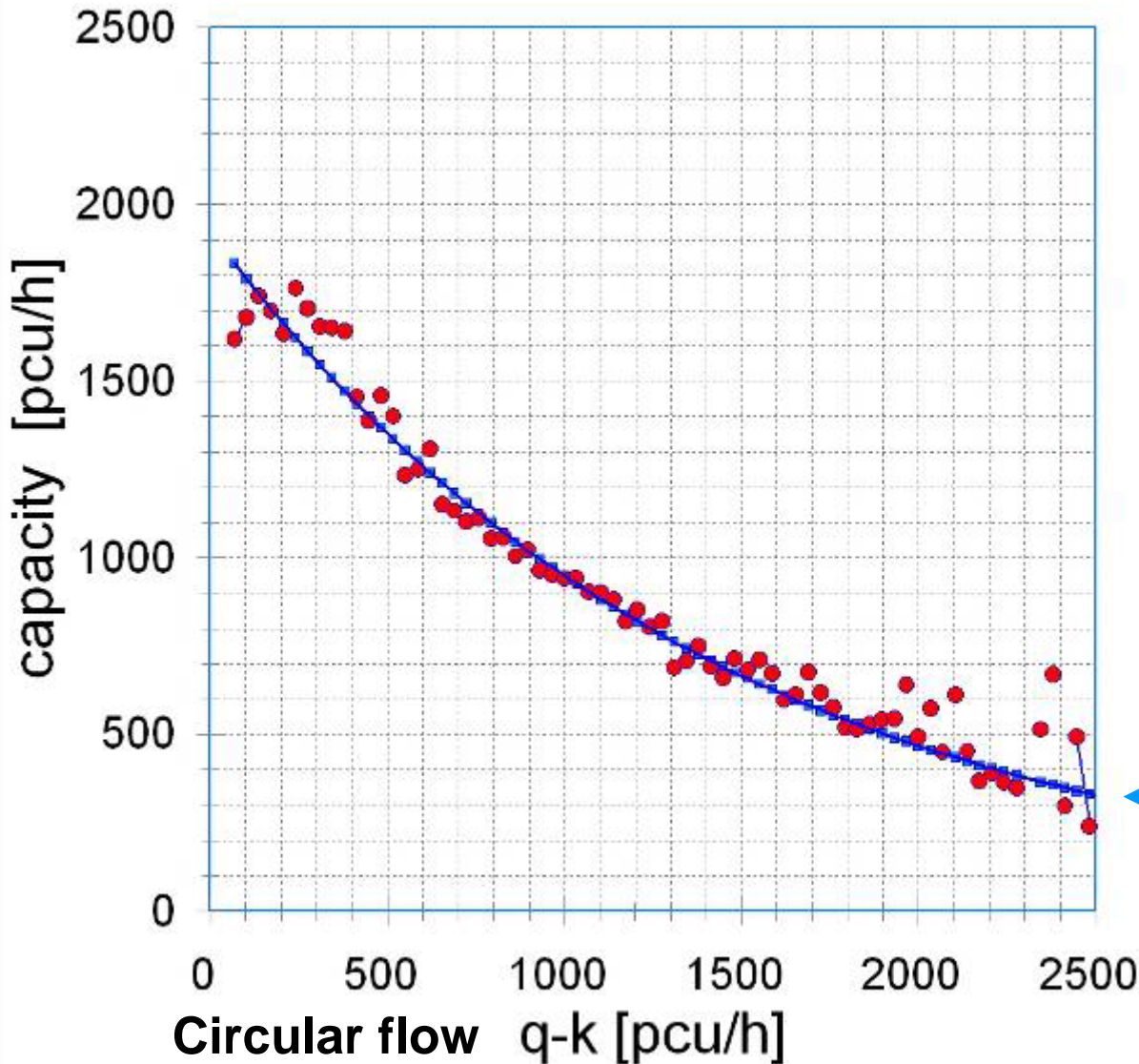

2-lane circulating

2-lane entry

(4500 data points)

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

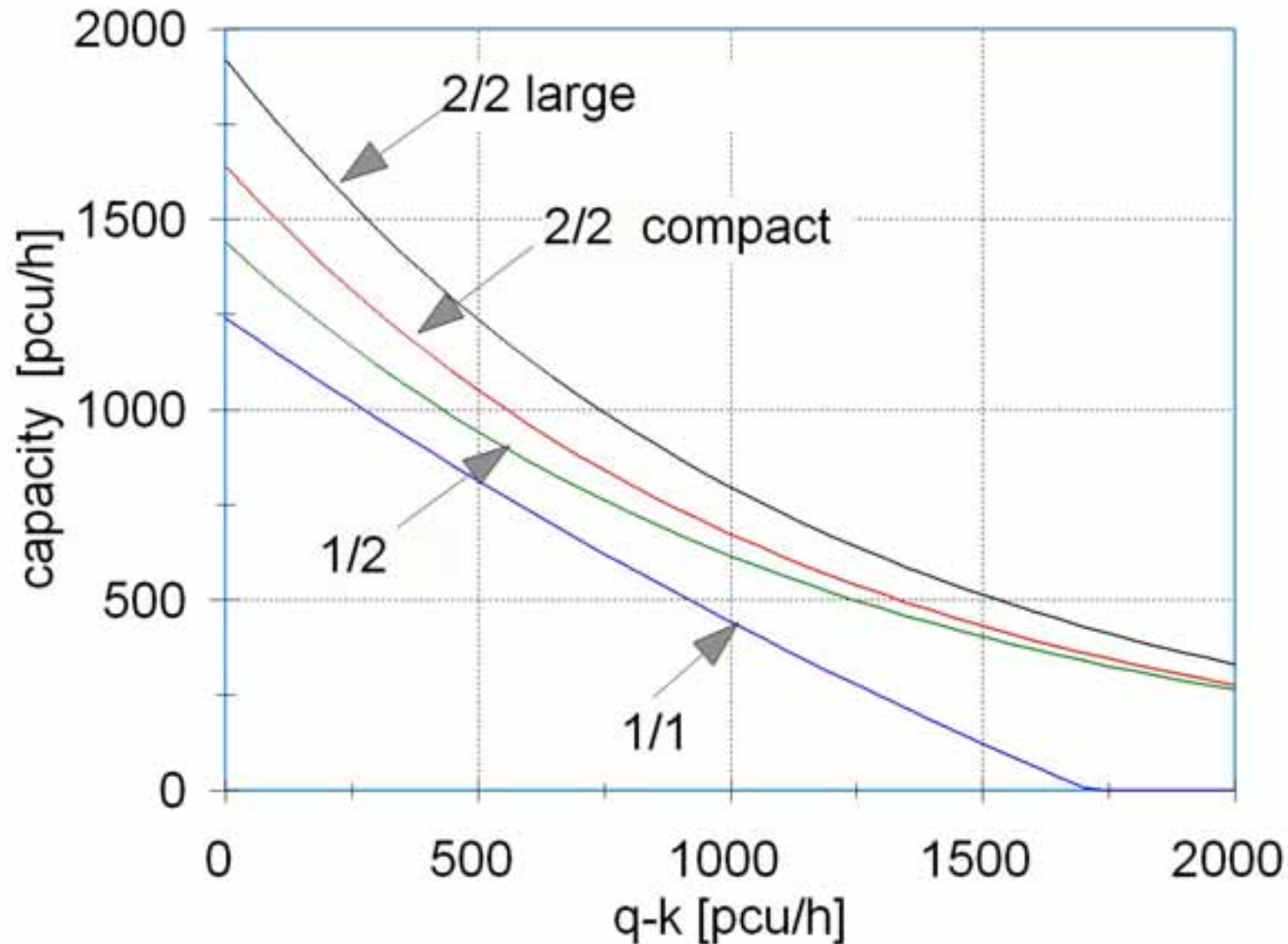# Capacity of Roundabouts (Method)
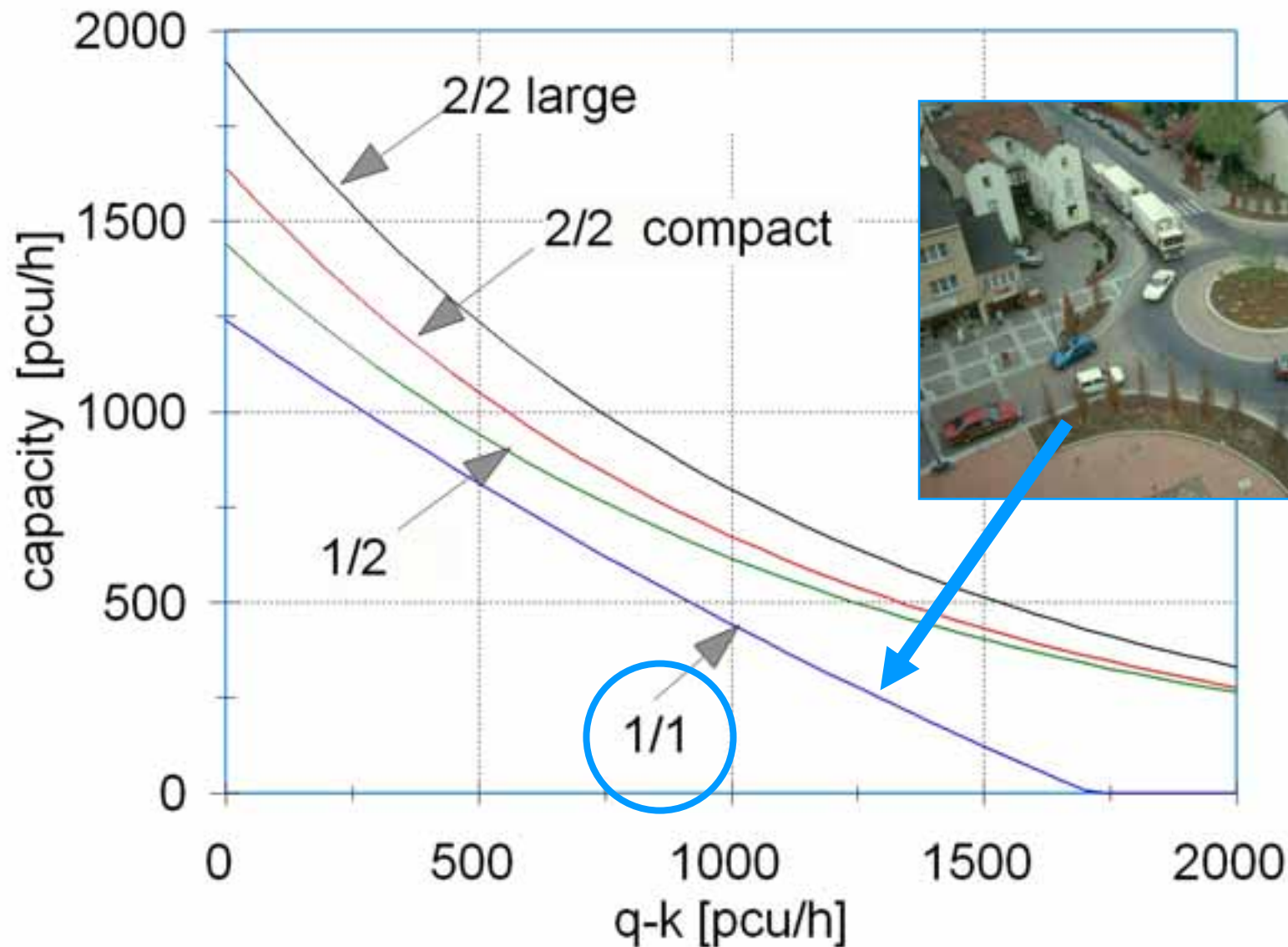

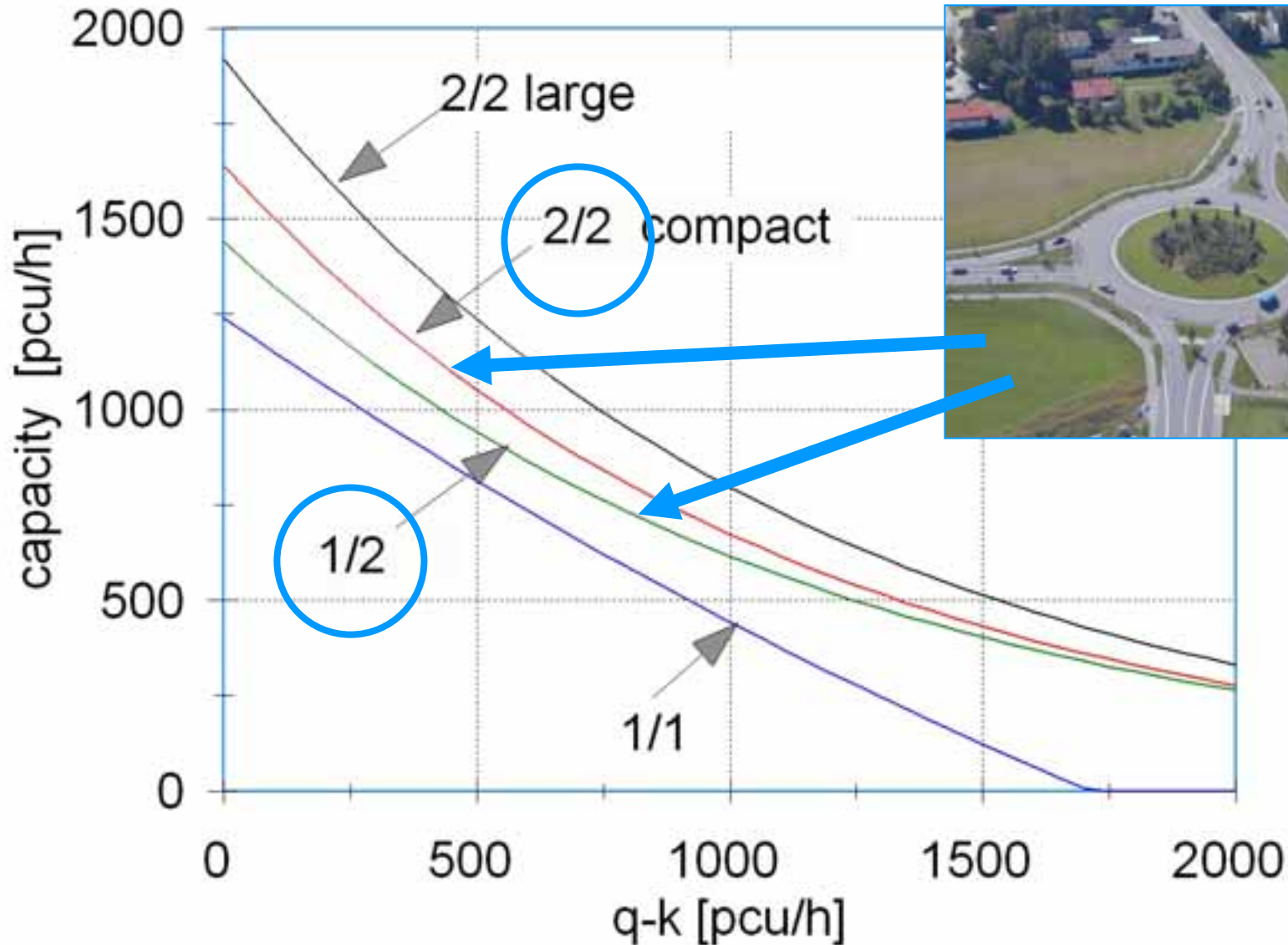**2-lane circulating**

2-lane entry

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

Capacity of Roundabouts

Capacity of Roundabouts

Capacity of Roundabouts

Capacity of Roundabouts

Capacity of Roundabouts

Graph — capacity [pcu/h] vs q-k [pcu/h], with curves labeled:
- 2/2 large
- 2/2
- 1/2
- 1/1

unused left entry lane
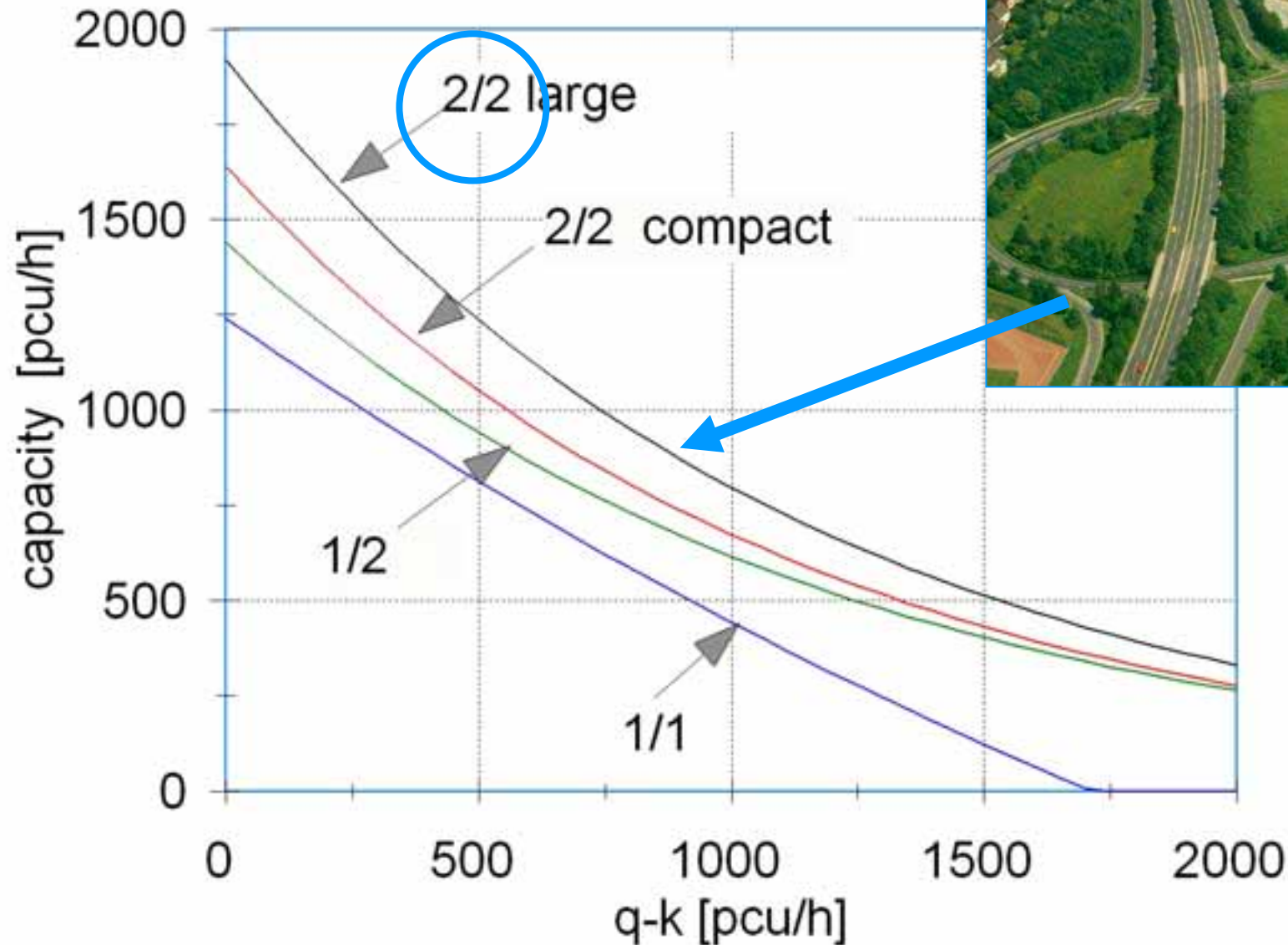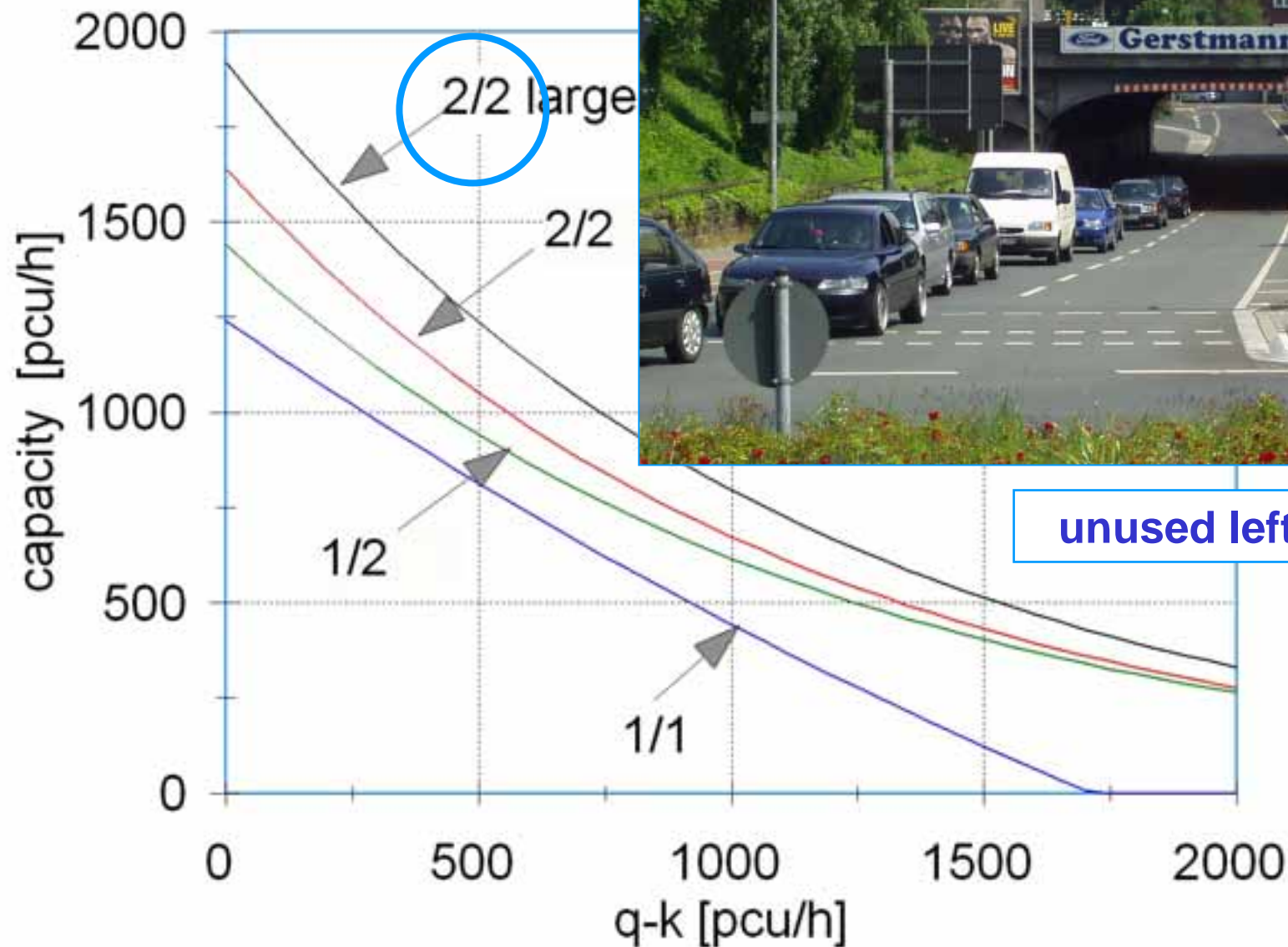
Capacity of Roundabouts

General applicability of roundabouts according to capacity

Lanes entry / circle :	1/1	compact 2/2	large 2/2	signalized 2/2
can be applied without capacity calculations below →	**15 000**	**16 000**	**20 000**	
has a maximum capacity of →	**25 000**	**32 000**	**35 000 - 40 000**	**50 000 - 60 000**
	veh/d			

Estimation of traffic performance:

Editing volumes for different types of vehicles

pass. cars

pcu per vehicle: 1

Rheindamm: 461 | U 0

58 | 112 | 291

125

Hansestrasse (West): 383

0

402 | 31 | 332 | 29

Traffic flows for a roundabout

4 : Rheindamm
Qa = 125
0   700 pc-units /h   Qe = 461
Qc = 462

1 : Hansestrasse (West)
Qa = 383
Qe = 402
Qc = 540

KREISEL 6, Select calculation methods

| Germany |
| Schweiz / Suisse |
| USA   USA |
| UK |
| France |
| Nether-lands |
| Polen |
| Sweden /Denmark |
| Israel |
| Australia |

Capacity, average delay, and queue length - with pedestrian influence

Verkehrsplanung Bonn
Hanseplatz
Morgenspitze

file :
HANSE.krs

Capacity, average delay, and queue length - with pedestrian influence

	Name	n-in	P+B	q-circle	q-e-dema.	q-e-max	x	Reserve	av. dly	L	L-95	L-99	LOS
	-	-	/h	pcu/h	pcu/h	pcu/h	-	pcu/h	s	pcu	pcu	pcu	-
1	Hansestrasse (West)	1	120	540	402	769	0.52	367	10	0,8	3	5	A
2	Adenauer Alle	1	120	654	345	683	0.51	338	11	0,7	3	5	B
3	Hansestrasse (Ost)	1	120	151	436	1086	0,40	650	6	0,5	2	3	A
4	Rheindamm	1	120	462	461	830	0,56	369	10	0,9	4	6	A

Inflow of all enries   =   1644   pcu/h
  here: motor veh. :   1644   veh/h
Sum of all delays   =   4,0   veh*h/h
average delay of all veh. =   8,8   s per veh.
Capacity:Germany: method after HBS 2001
Delay   :Brilon (1995) with factor = 0,8 / T = 3600 s
Queue: Wu, 1997

Overall performance level   B

Help   OK

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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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