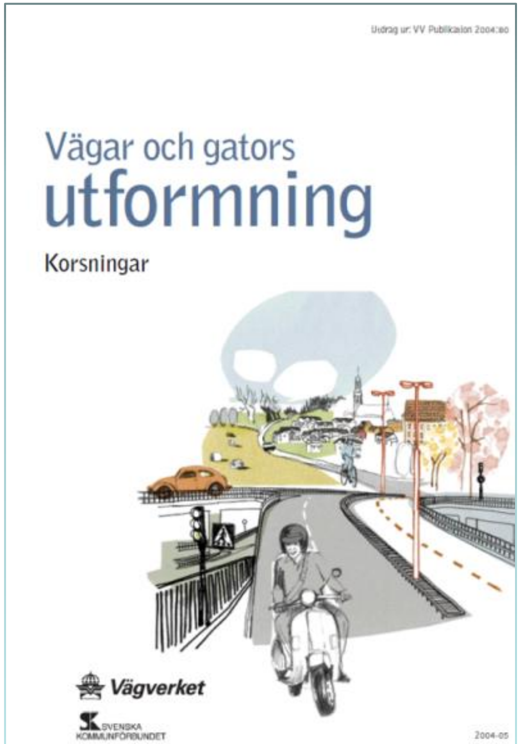
Swedish Roundabout´s

Design, capacity and safety

Swedish principles of roundabout´s design

- Swedish guidelines today



http://www.trafikverket.se/Foretag/Bygga-och-underhalla/Vag/Utformning-av-vagar-och-gator/Vagar-och-gators-utformning/Vagar--gators-utformning/Korsningar/

- Swedish guidelines 1950

Cirkulationsplatser 81.

Fig. 5. Nybroplan, Stockholm

Cirkulationsplatser

NÄR SKALL MAN BYGGA EN CIRKULATIONSPLATS?

Ett enkelt och jämförelsevis billigt sätt att reglera trafiken på en öppen plats eller i ett gatukors är att bygga en cirkulationsplats (fig. 5). Förutsättningen är att man har tillräckligt utrymme till sitt förfogande. Ofta är detta dock inte fallet när det gäller redan färdigbyggda stadsdelar.

Principen för en cirkulationsplats är att all trafik i riktning mot platsen tvingas att sakta in och köra runt en mittrefuge i en enkelriktad körbana. Under körningen runt mittrefugen korsar bilarna varandra under sned vinkel och trafikströmmarna "väver" igenom varandra. Man kallar den sträcka där "vävningen" sker för *växlingssträcka* (fig. 6).

Fördelen med en cirkulationsplats jämfört med ett ljussignalreglerat gatukors är att trafiken löper kontinuerligt. Den får visserligen sakta farten men behöver som regel inte stanna. När det gäller att reglera en korsning mellan fler än två korsande trafikleder är cirkulationsplatsen bättre än en signalreglerad korsning som i detta fall kan bli mycket komplicerad.

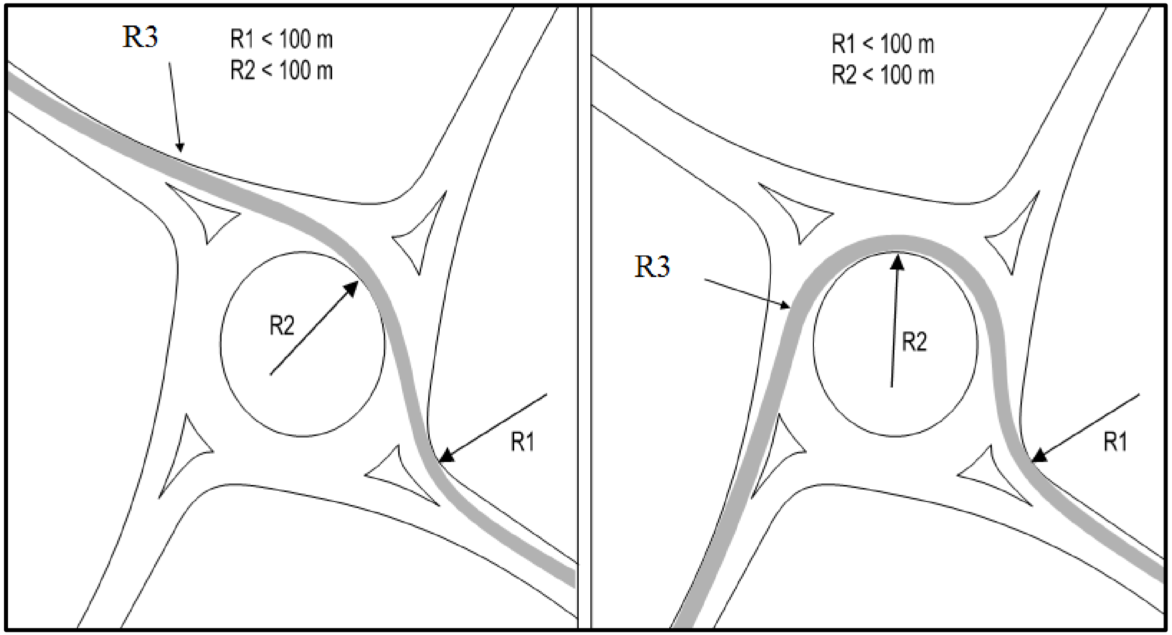
En cirkulationsplats kräver emellertid mycket större utrymme. Om trafiken är stor är det dessutom svårt för cykeltrafiken att växla med motortrafiken samt för fotgängarna att ta sig över körbanorna.

Det är motiverat att anlägga en cirkulationsplats när den sammanlagda inkommande trafiken är 500 fordon per maximitimme eller mer och trafiken på den mindre vägen är mer än 25 % av den totala trafiken.

6 Gatan

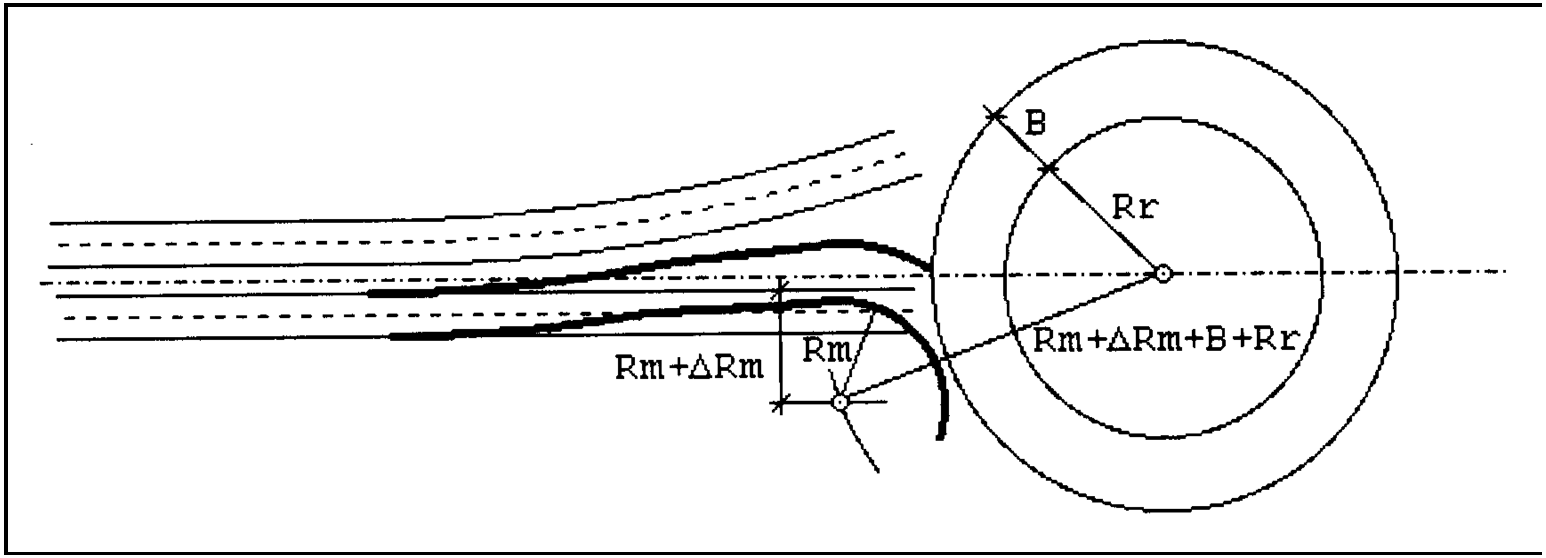
Roundabout traffic safety design

- *R1<=R2<=R3*
- *Car speeds around 30 km/h if R<50*
- *50 R<100*
- *track width car some 2 m, bus and truck some 3-4.5 m*



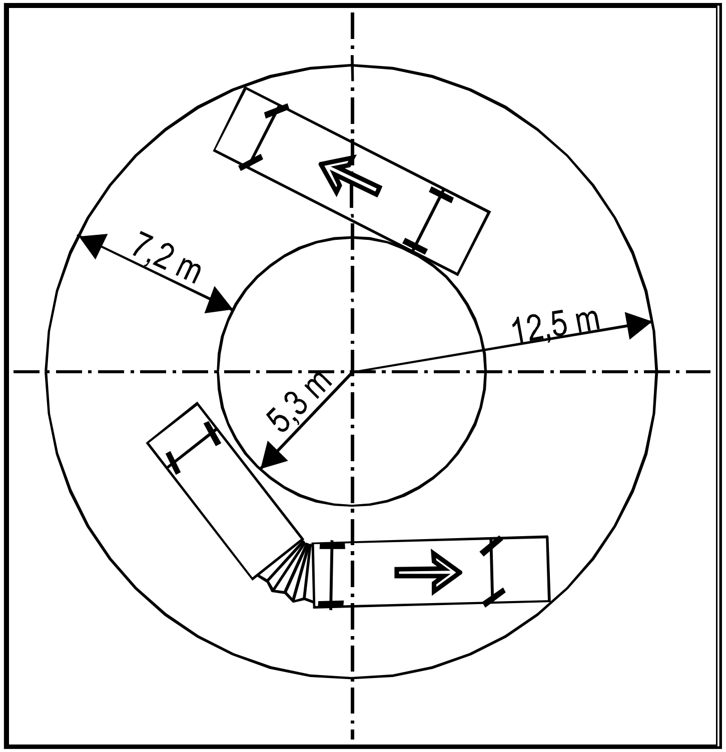
Roundabout traffic safety design

- **High speed approach might need deflection**



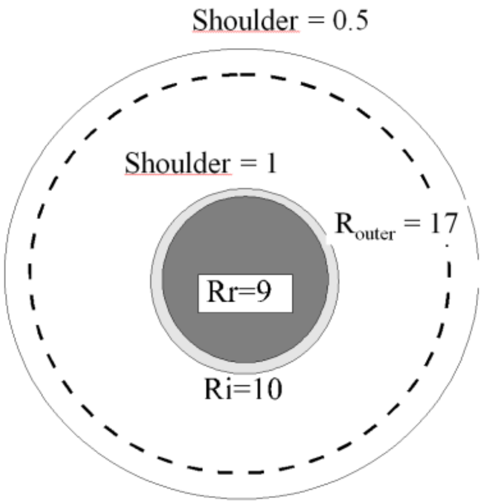
Design regarding buses and HGV

- Buses and articulated trucks
  - Boggie buses some 15 m
  - Trucks with trailers 25,3 m
  - Semi trailers EU 16,5

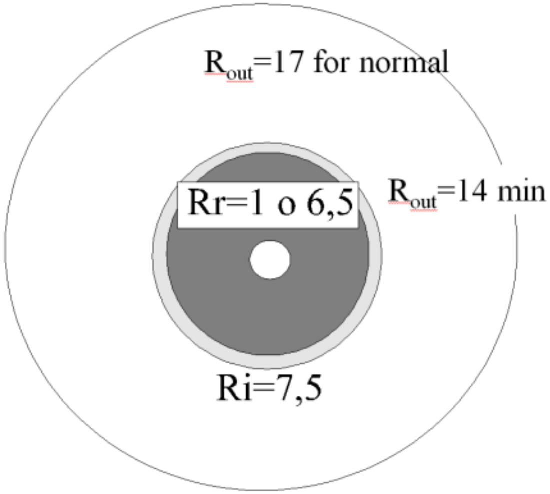


Minimi inner and outer radii – single lane

- **Rural and urban areas**
  - **Minimum normal roundabout for comfortable driving for large ”Swedish” HGV**

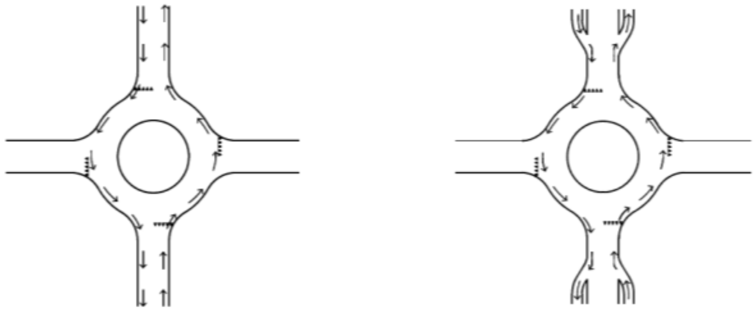


- **Only urban areas**
  - **Minimum partly driveable central island - very uncomfortable driving for large ”Swedish” HGV– only urban**

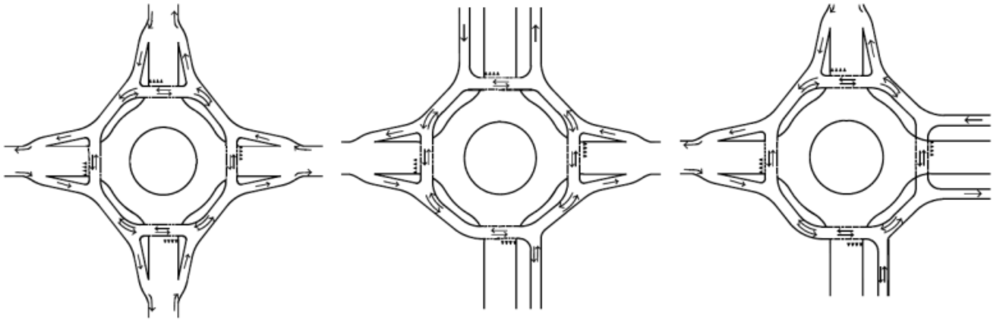


Design for cyclists

- **Cyclists not separated**



- **Cyclists separated**

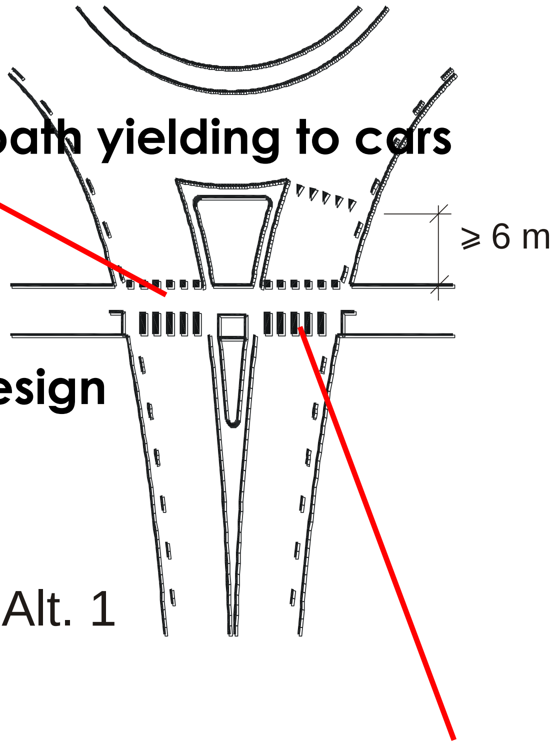


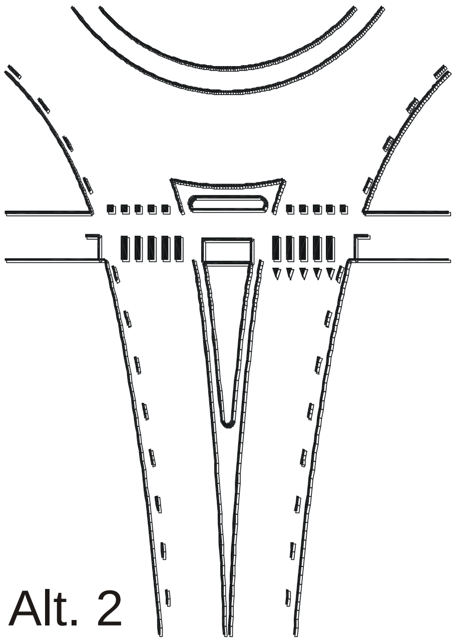
Design for pedestrians

Most common

Bicycle path yielding to cars

Raised design common





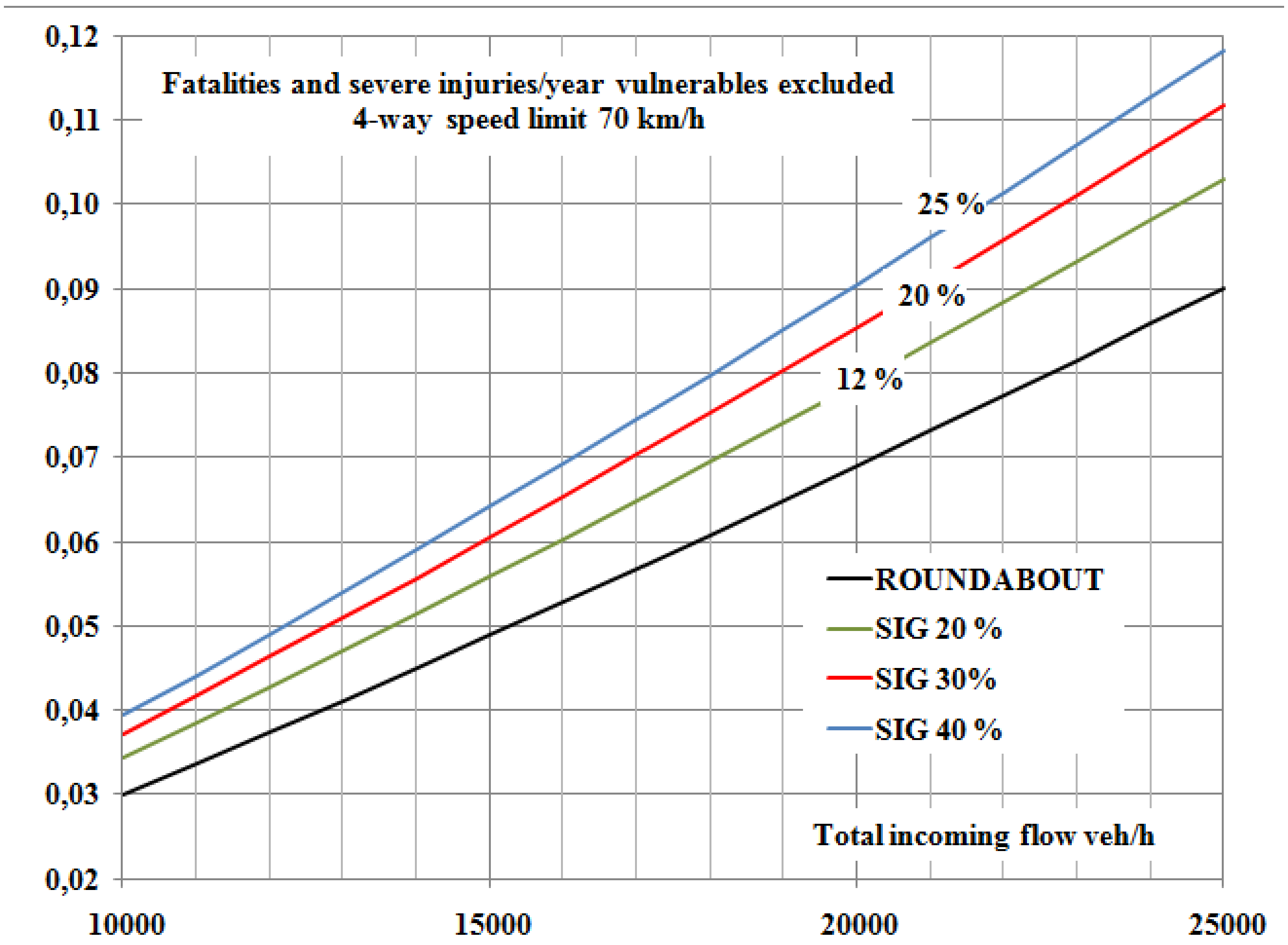
Pedestrian crossing cars yielding to peds

Typical urban roundabout

Typical rural roundabout

Typical gyratory

Traffic safety effects according to Swedish EVA



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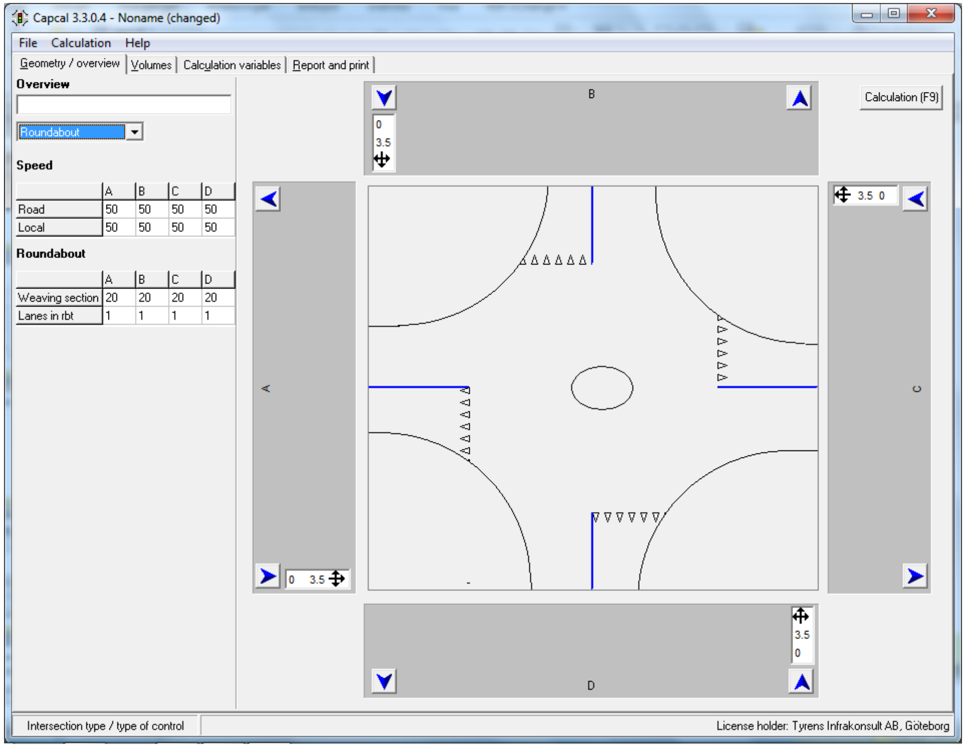
Capacity calculations - Capcal

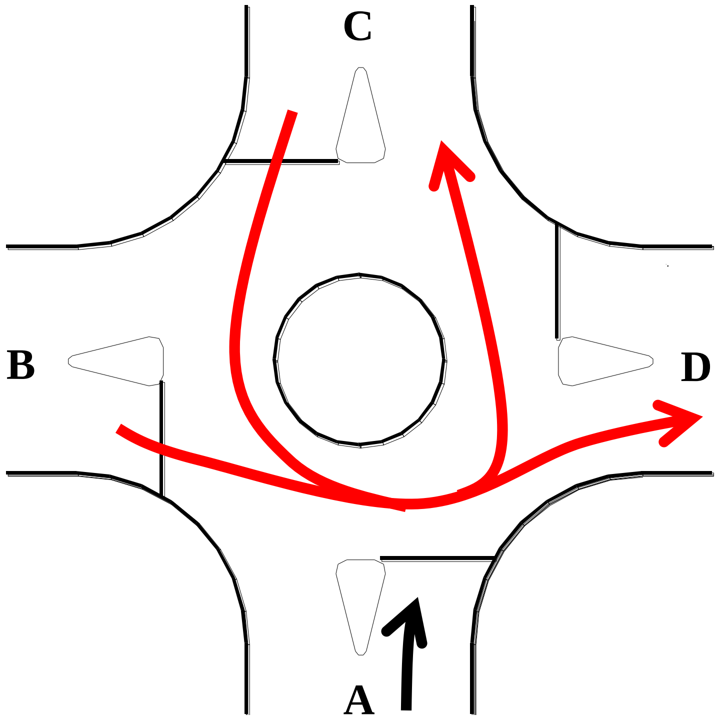
- Capcal – The official program
  - Analytic traffic model based



Capacity calculations - Capcal

- **Single lane roundabout major flow**

$$Qmajor\_a = Qbd + Qbc + Qcd$$



Heavy vehicles   pcu=2
Bicycle and pedestrian pcu=0.5

Capacity calculations - Capcal

- **Two lane roundabout major flow (Hagring)**

$$q_{AF} = \beta_I v_{BI\to D} + \beta_O v_{BO\to D} + \gamma_I v_{BI\to C} + \gamma_O v_{BO\to C} + \delta_I v_{CI\to D} + \delta_O v_{CO\to D}$$

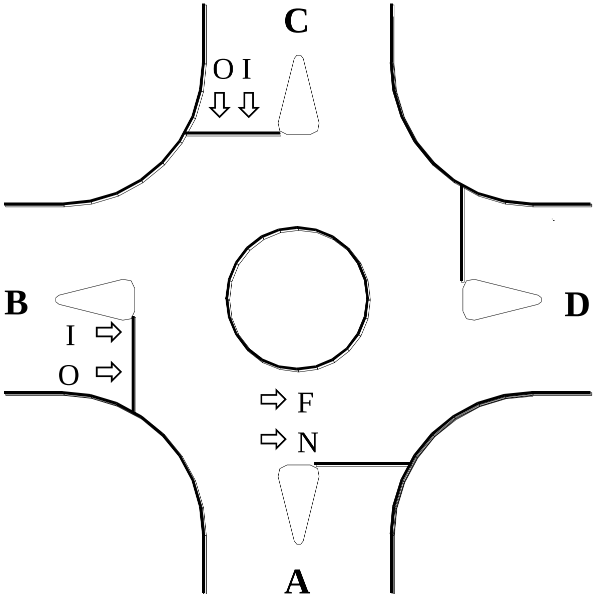
$$q_{AN} = (1-\beta_I)v_{BI\to D} + (1-\beta_O)v_{BO\to D} + (1-\gamma_I)v_{BI\to C} + (1-\gamma_O)v_{BO\to C} + (1-\delta_I)v_{CI\to D} + (1-\delta_O)v_{CO\to D}$$

β, γ , δ ratio of major flow using inner circular lane F in the roundabout.

In Capcal

$\beta_I, \gamma_I, \delta_I = 1$

$\beta_O, \gamma_O, \delta_O = 0$



Capacity calculations - Capcal

Major flow headway distribution M3 Cowan

$$F(t) = 1 - \alpha e^{-\lambda(T - \overline{\Delta})} \qquad T \geq \overline{\Delta}$$

$$\alpha = 0.910 - 1.545q$$

$$\overline{\Delta} = (1 + p_{HV})\,1.8$$

$$\lambda = \frac{\alpha\, q}{1 - q\Delta}$$

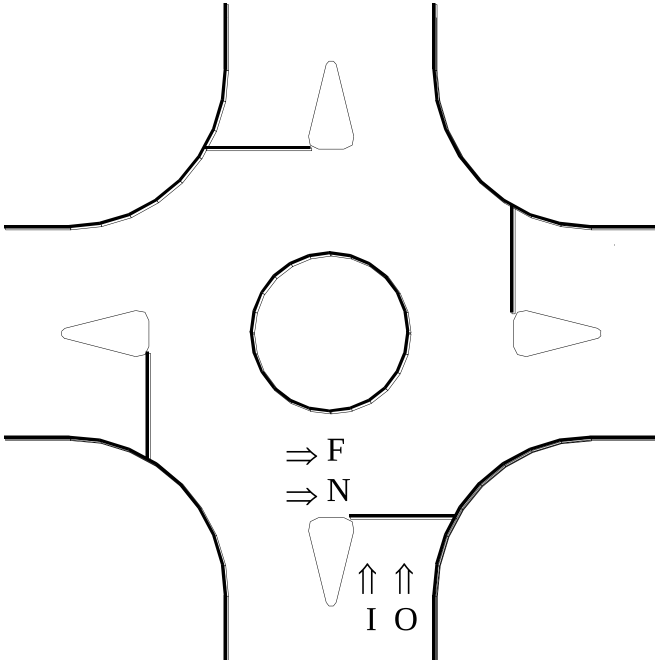
Capacity calculations – Capcal critical gaps and follow ups

$$T = 5.659 - 0.062 w_L + 1.1(p_{HV} - 0.056) \qquad w_L \le 35$$

$$Tright = T - 0.462$$

Two lane roundabout:

Minor lane	Major lane	
	Near lane	*Far lane*
Outer lane, excl. right turns	0.138	-0.138
Outer lane, right turns	-0.324	-0.600
Inner lane	0.726	0.514



Follow up:: $$T_0 = 2.40 + 1.1(p_{HV} - 0.061)$$

Capacity calculations – Capcal capacity

One lane:

$$C = \alpha\, q \frac{e^{-\lambda\left(T-\bar{\Delta}\right)}}{1-e^{-\left(\lambda\, T_0\right)}}$$

$$\alpha = 0.910 - 1.545q$$

$$\bar{\Delta} = \left(1 + p_{HV}\right) 1.8$$

$$\lambda = \frac{\alpha\, q}{1 - q\Delta}$$

Two lanes:

$$C = \left(\lambda_1 + \lambda_2\right) \frac{\alpha_1 \alpha_2 q_1 q_2}{\lambda_1 \lambda_2} \frac{e^{-\left(\lambda_1 T_1 + \lambda_2 T_2\right)}}{e^{-\left(\lambda_1 + \lambda_2\right)\bar{\Delta}} \left(1 - e^{-\left(\lambda_1 + \lambda_2\right) T_0}\right)}$$

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Capacity calculations – Capcal service time

Iterative procedure with service times:

- non queing $D_q = 1/C$

- queing

$$D_n = \frac{e^{\Lambda(T-\Delta)}}{Q\mathrm{A}} - T - \Lambda^{-1} + \frac{\Lambda\Delta^2 + 2\mathrm{A} - 2\Delta + 2\mathrm{B}\Delta^2 - \frac{4}{3}\Lambda\Delta^3\mathrm{B}}{2\Lambda\Delta + 2\mathrm{A} - 2B\Delta^2\Lambda}$$

$$\mathrm{A} = \frac{\alpha_1 q_1 (1 - \Delta q_2) + \alpha_2 q_2 (1 - \Delta q_1)}{Q} \qquad \mathrm{B} = \frac{q_1 q_2}{Q}$$

- degree of saturation $\rho = \sum q_m D_{mn}$
- average service time $D = \rho D_q + (1-\rho) D_n$
- degree of saturation $\rho = qD$

Capacity calculations – Capcal queu lengths L and waiting times d

$$L = \left\{ -C\tau(1-\rho) + \left(C^2\tau^2(1-\rho)^2 + 4(\rho C\tau + 1)\right)^{1/2} \right\} / 2 .$$

$$d_q = \left\{ -(2 + C\tau - \rho C\tau) + \left((2 + C\tau - \rho C\tau)^2 + 8\rho C\tau\right)^{1/2} \right\} / (4C).$$

τ Time considered normally 1 hour

C Capacity

ρ Degree of saturation

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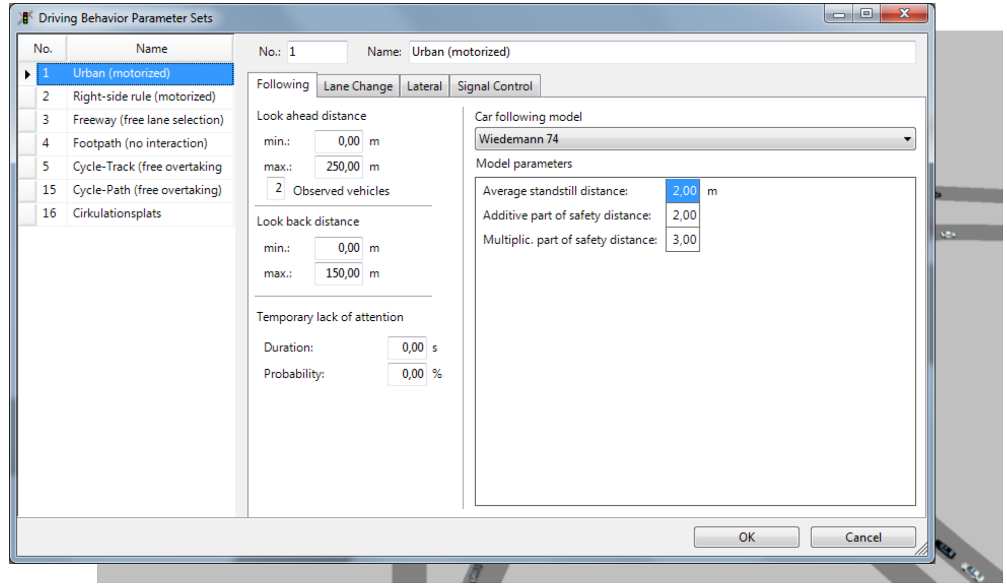
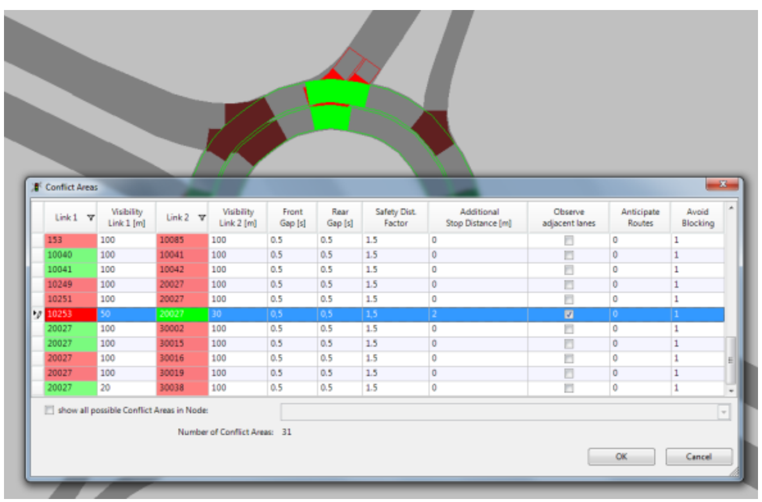
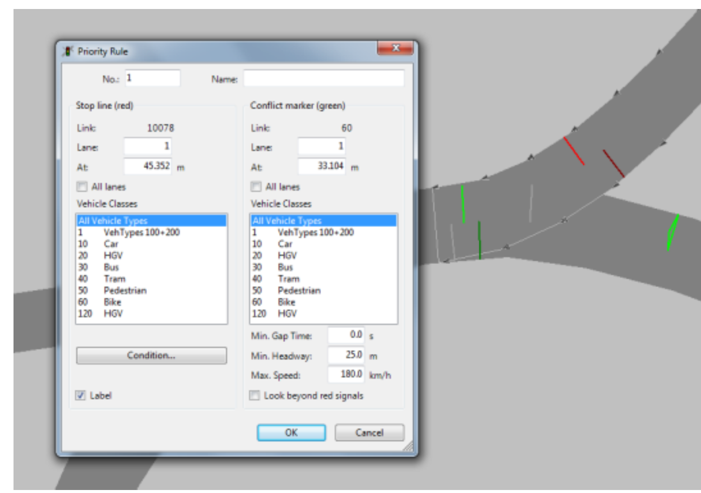
Capacity "calculations" - Vissim

- Parameters to calibrate
  - Conflict areas vs Priority Roles
  - Drivning Behavior
  - Speed etc







MetKap - Methods for highway capacity analysis

- Develop methods and tools for capacity analysis, design and impact evaluation for different types of road links, intersections and traffic interchanges
  - When to use traffic simulation?
  - How should traffic simulation be used to conduct capacity analysis?
  - How to calculate saturation flow and capacity from simluation data?
  - What are the requirements for calibration and validation?
  - How to use traffic simulation to compare different road and intersection designs?

- Tyréns part – Analysis of Roundabout's.
  - What parameters to calibrate, their effect on the simulation and recommended values.
  - How to conduct field studies, methods, what to observe etc, cost efficient!!

- Final Report Dec 2012

TYRÉNS

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