NTNU
Traffic Engineering
Research Centre

# Modelling of pedestrians and bicycles (mainly at roundabouts)

SIDRA User meeting

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# Content

- Introduction
- Important factors for pedestrian modelling
- Pedestrian modelling at roundabouts in SIDRA
- Some results from field observations
- Comparison with SIDRA

# Why model pedestrians and bicycles?

- Intersection modelling is about solving conflict between differeent movements
- Traditionally we have had most focus on conflicts between vehicles
- But pedestrians and bicycles play an important role within intersection modelling
- In Norway we have agreed on the «Zero-growth objective»:
  Zero growth of private cars in the cities, which means that all growth in transport has to be made by public transport, bicycle or by foot
- We should include and calculate travel time, delay etc for pedestrians and bicycles as well as we do it for vehicles
- We could give special priority to different movements

# Modelling of pedestrians and bicycles

- Pedestrians and bicycles are very different and should be modelled separatly
- Pedestrian and bicycle movements will affect vehicle movements
- Vehicle movements will affect pedestrian and bicycle movements
- Different pedestrian and bicycle movements will also affect eachother

# Pedestrians at roundabouts

- Master thesis 2018
  Lena Holte / Silje Ådland Riise:

  Fotgjengeres påvirkning på trafikkavvikling i rundkjøringer

  (*How pedestrians affect quality of traffic flow in roundabouts*)

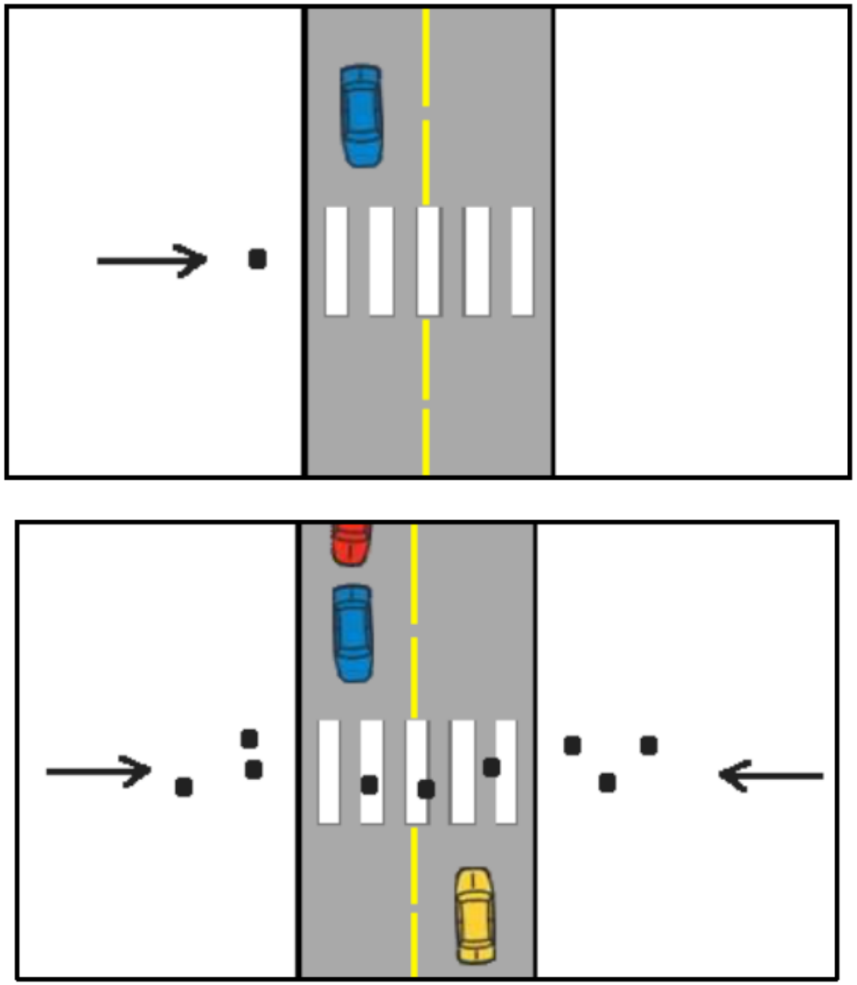
- Theory, field observations and modelling by SIDRA and AIMSUN

- Entry and exit capacity

- Some important factors are described on the following pages

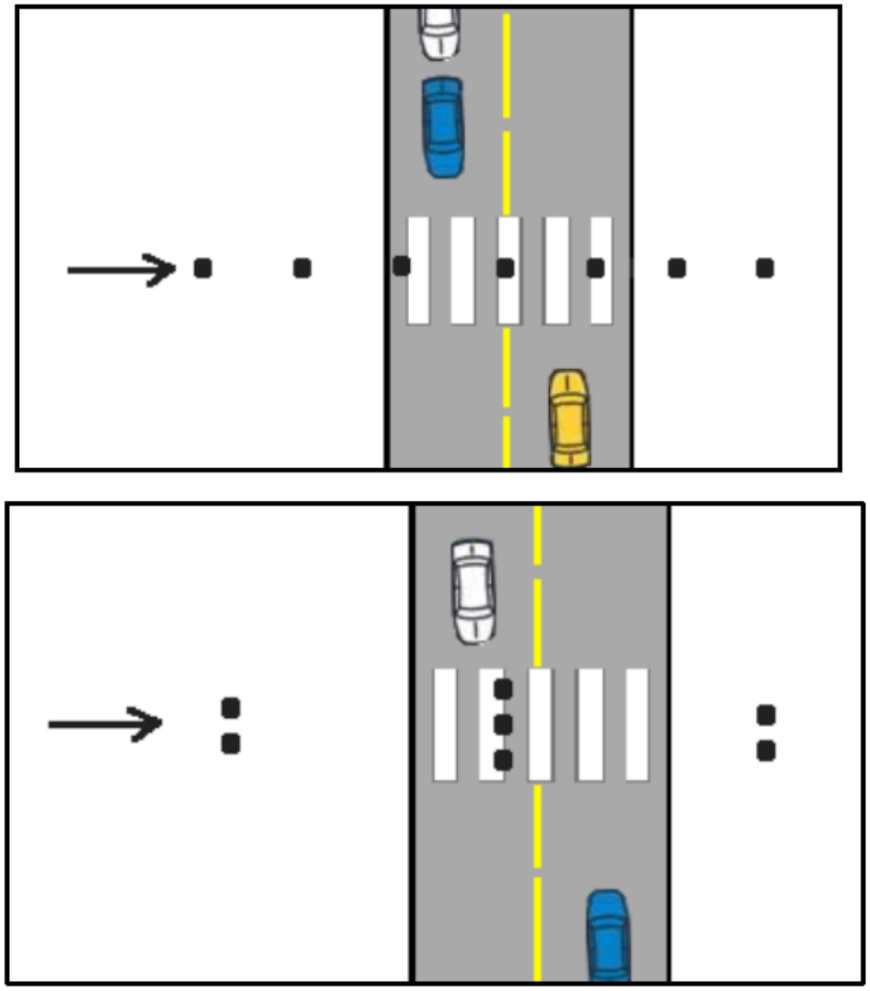
# 1 Number of pedestrians

- The number of crossing pedestrians is obviously an important factor for how much the pedestran crossing is blocking for vehicles



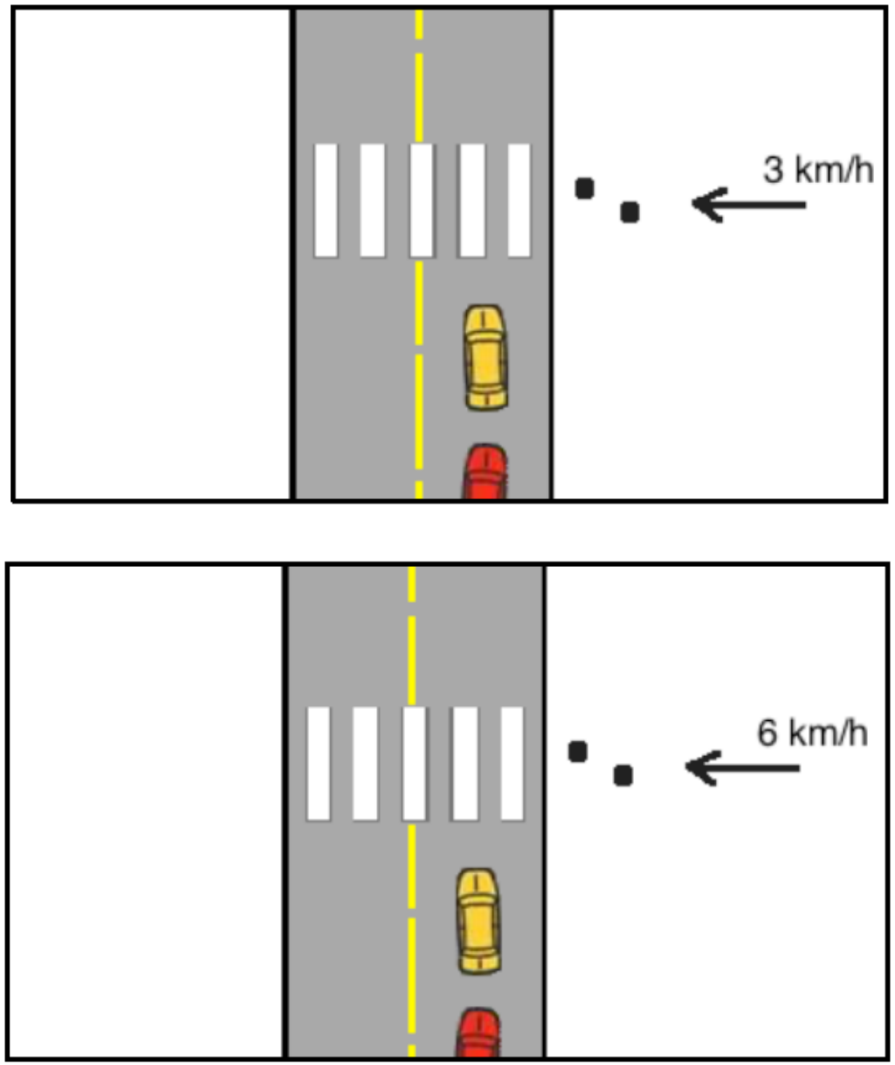
# 2 Pedestrian arrival pattern

- Arrival distribution
- Platooning



# 3 Pedestrian walking speed

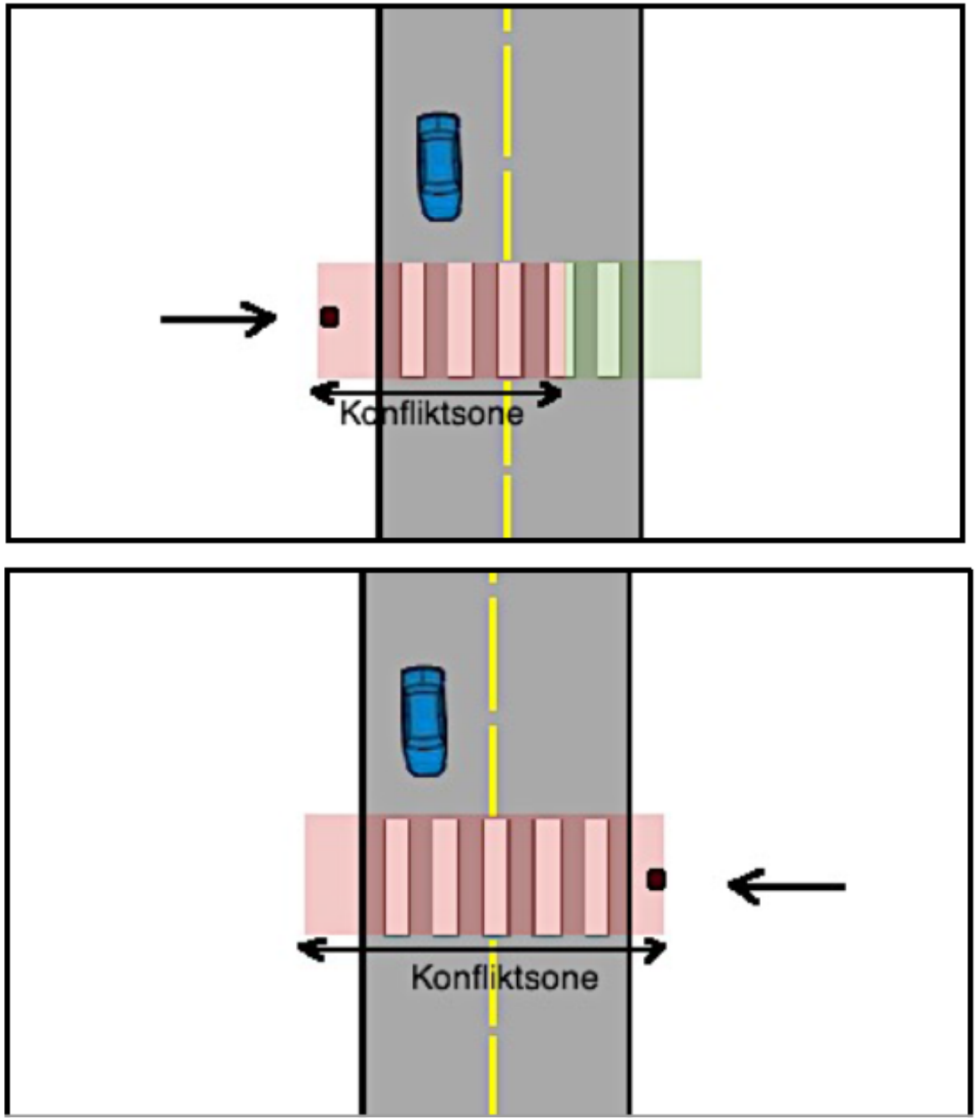
- Pedestrian speed will affect how long time the pedestrians are blocking for vehicles



# 4 Length of conflict zone

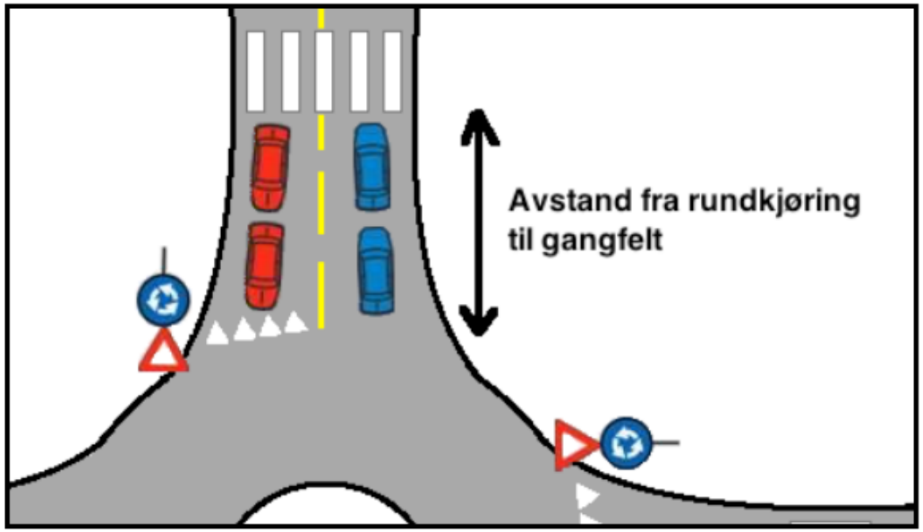
- The length of the conflict zone will vary dependent on
  - pedestrian direction
  - driver / pedestrian behaviour
  - legal issues
  - etc

- The blocking time will be decided by length of conflct zone and pedestrian speed



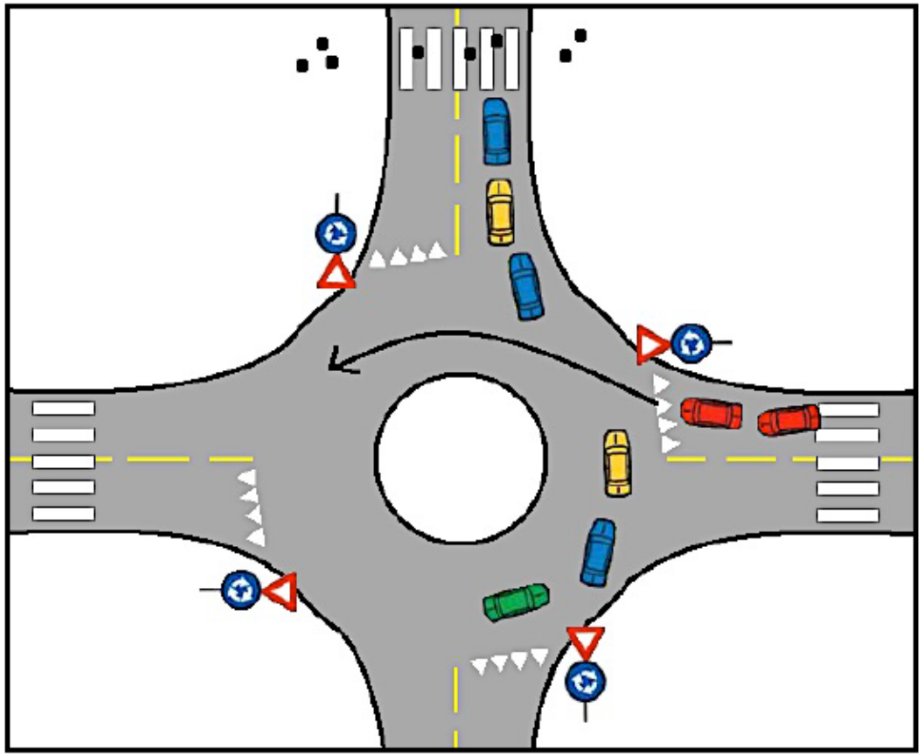
# 5 Distance from crossing to stopline

- The distance from the pedestrian crossing to the roundabout stop line (queue space) is an important factor
- Entry capacity is affected if this queue space is less than 3 vehicles (Duran and Cheu, 2012)
- But what about exit capacity?



# 6 Driver behaviour and cooperation

- Driver behaviour and cooperation
- Understanding of the traffic situation
- Unnecessary blocking of other movements
- «Yellow box»



# Pedestrian modelling at roundabouts in SIDRA

- A correction factor for **entry capacity** is calculated based on a method from HCM 2016

- Different formulas for single and multiple lane roundabouts

- Single lane roundabout:

$$f_p = 1{,}0 \qquad hvis\ q_c > 881\ ellers$$

$$= 1 - 0{,}000137 \cdot q_p \qquad hvis\ q_p \leq 101\ ellers$$

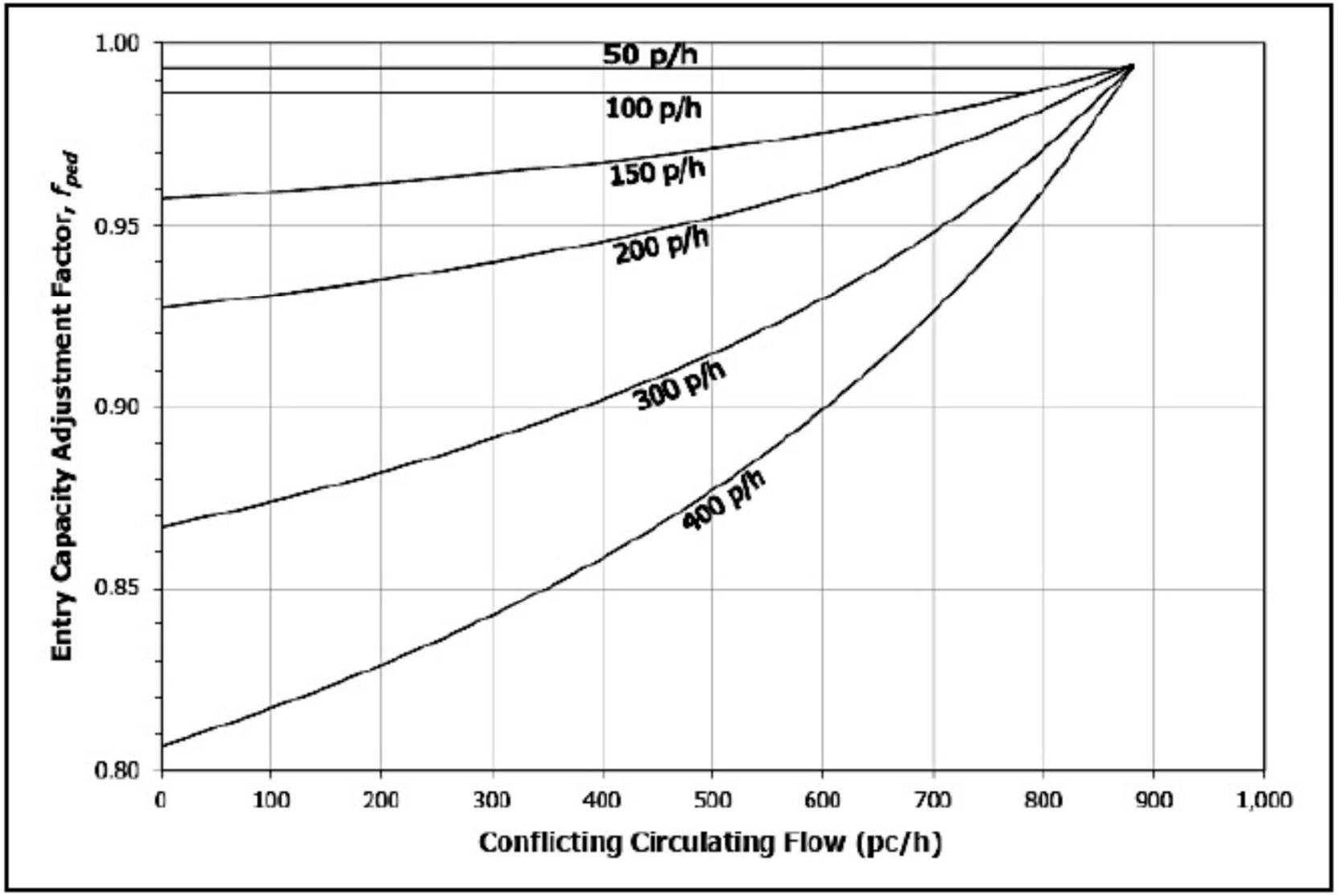
$$= \frac{1119{,}5 - 0{,}715 \cdot q_c - 0{,}644 \cdot q_p + 0{,}00073 \cdot q_p \cdot q_c}{1068{,}6 - 0{,}654 \cdot q_c} \qquad hvis\ q_p > 101\ og\ q_c \leq 881$$

- Multiple lane roundabout:

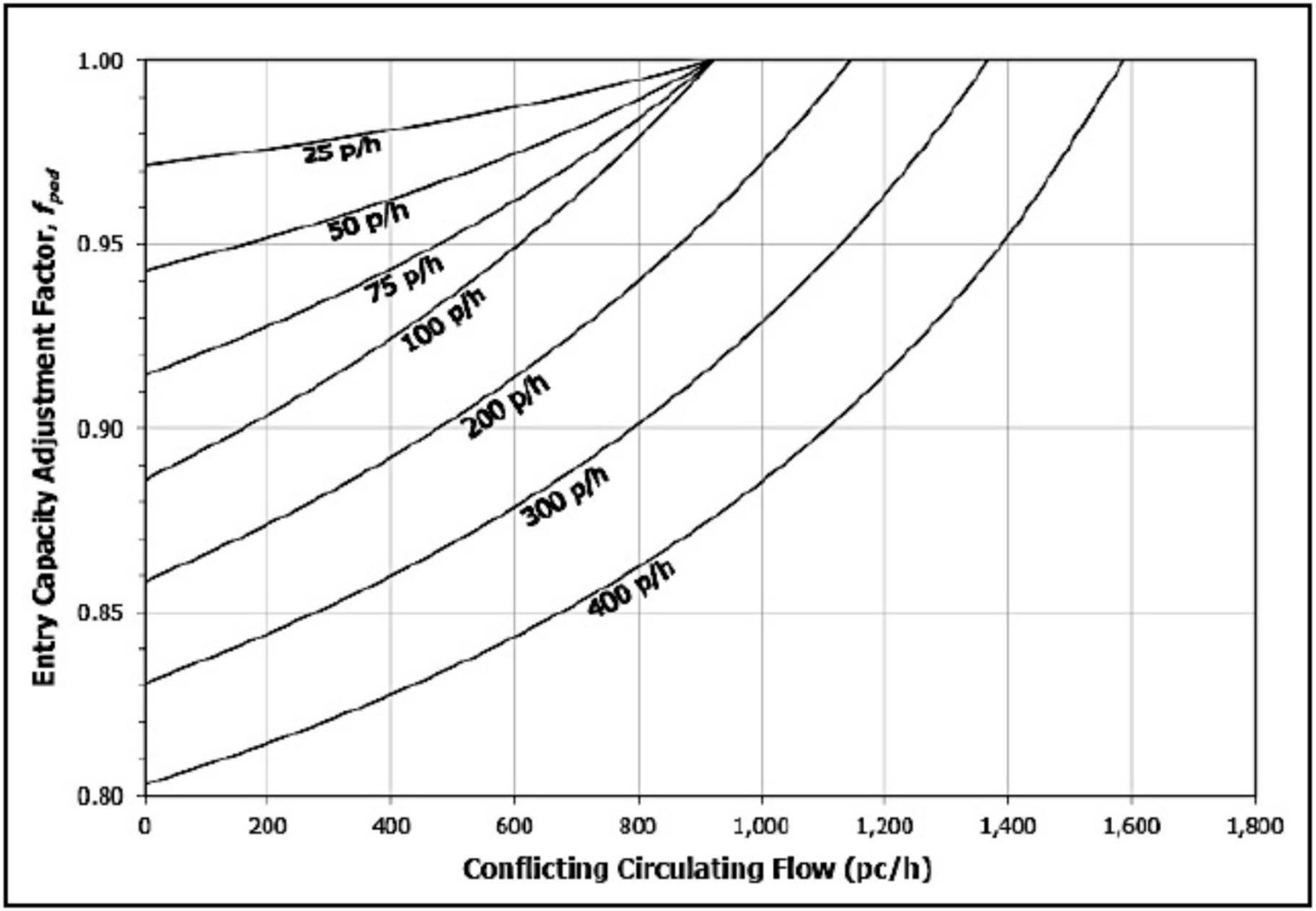
$$f_p = \min\left\{1.0\ , \frac{1260.6 - 0.329q_c - 0.381q_p}{1380 - 0.50q_c}\right\} \qquad hvis\ q_p \geq 100$$

$$= \min\left\{1.0\ , 1 - \left(\frac{q_p}{100}\right)\left(1 - \frac{1260.6 - 0.329q_c - 38.1}{1380 - 0.50q_c}\right)\right\} \qquad hvis\ q_p < 100$$

# Single lane roundabout



# Multiple lane roundabout



# Exit capacity in SIDRA

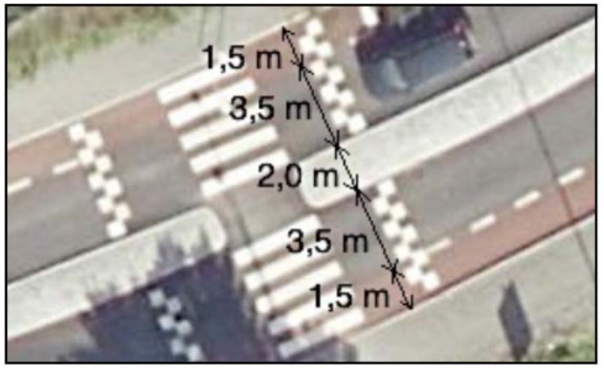
- There is a method for calculating exit capacity in SIDRA based on a gap acceptance model
- But this exit capacity is not used for any corrections, queue or delay calculations?
- A critical time gap ($t_c$) is found based on length of the conflict zone and average pedestrian speed
- Follow-up headway ($t_f$) is set to 60% of this value
- Exit capacity ($Q_g$) is calculated based on the Akcelik M1 model

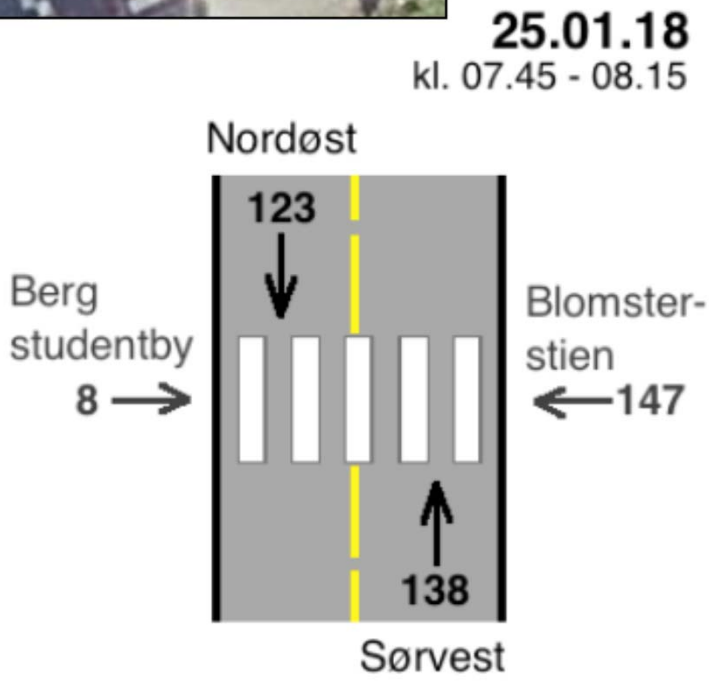
$$t_c = \frac{L_c}{v_{pa}} \qquad t_f = \max(2.0, 0.6t_c)$$

$$Q_g = \left(\frac{3600}{t_f}\right)(1 + 0.5q_p t_f)e^{-q_p t_c}$$

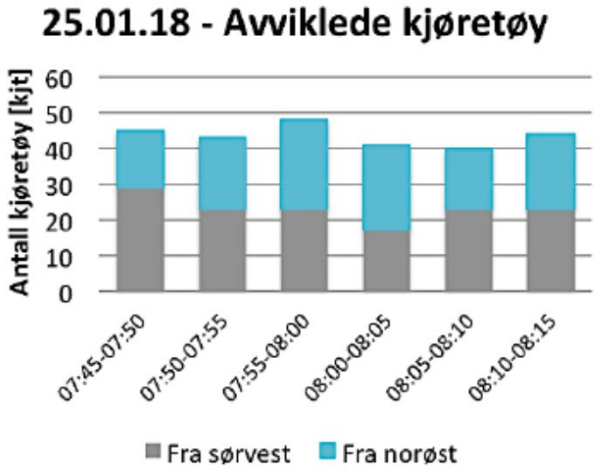
# Simplified example: Pedestrian crossing

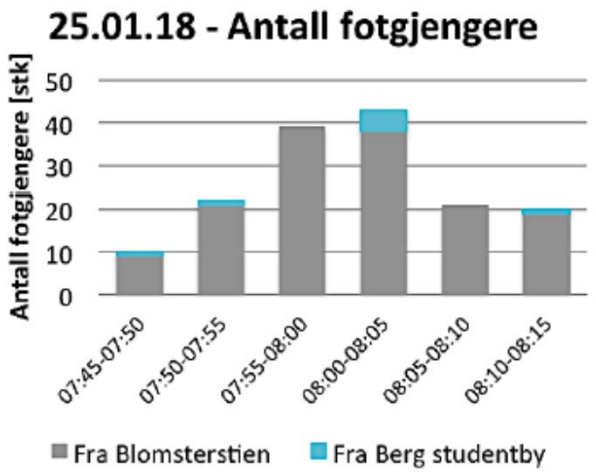
- We were first looking at a pedestrian crossing on a road section

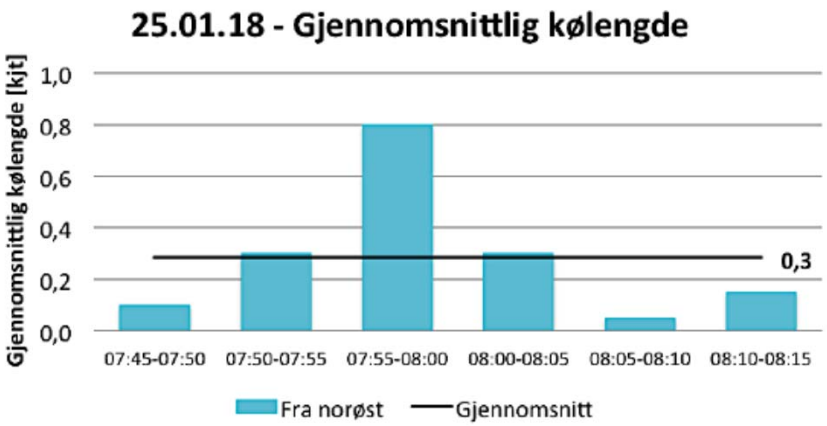


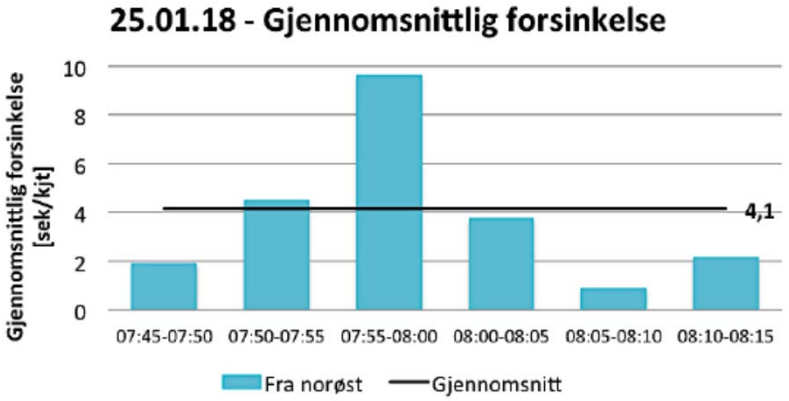



# Example of observations



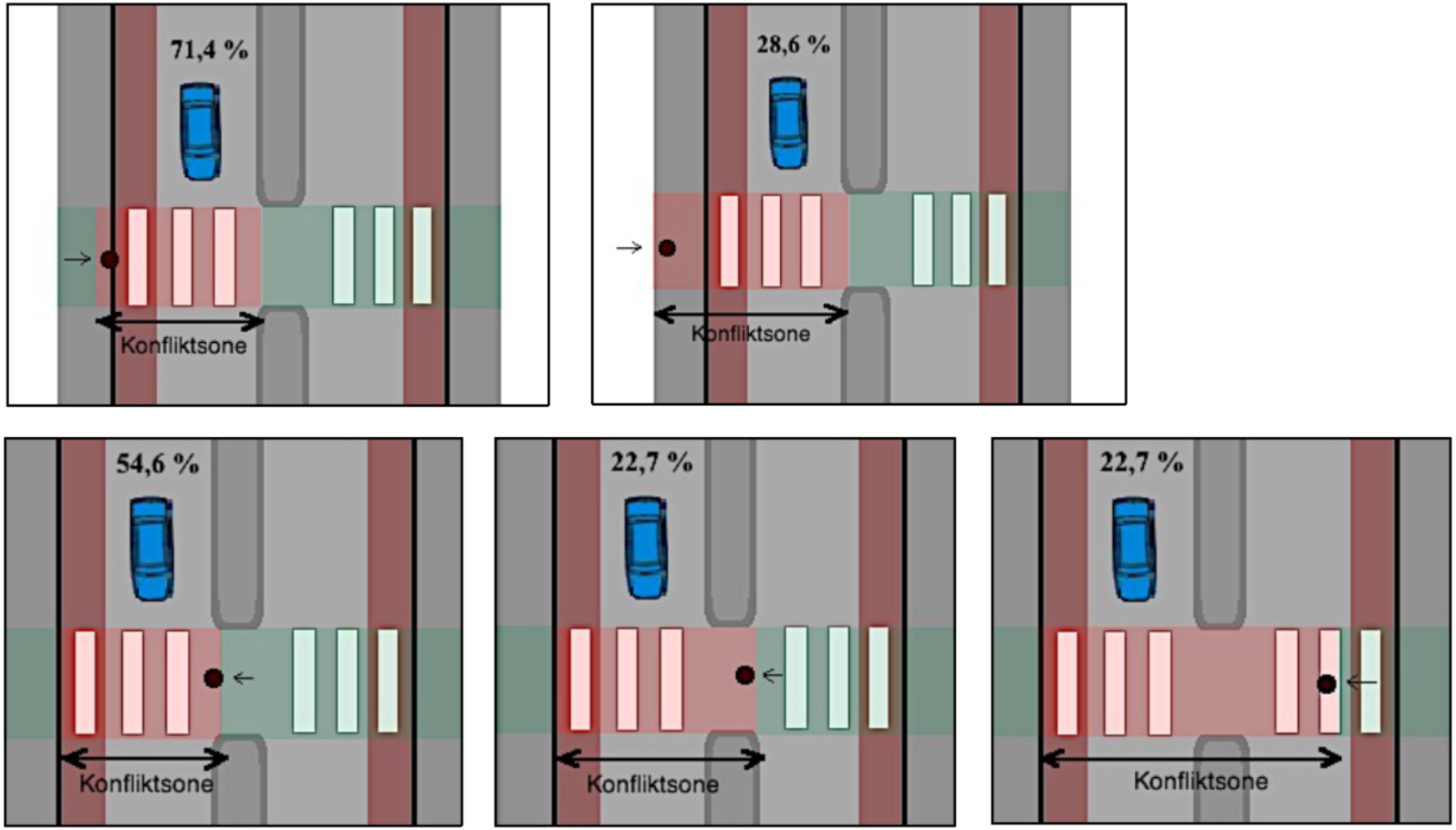



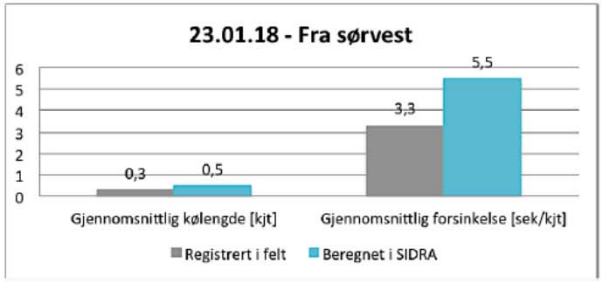
# Example of observations

- Avg walking speed:1.6 m/s
- Length of conflict zone (see below)

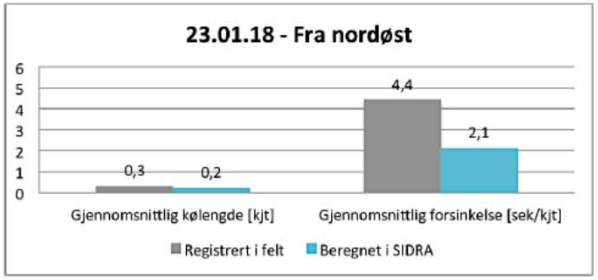


# Observations vs SIDRA calculations

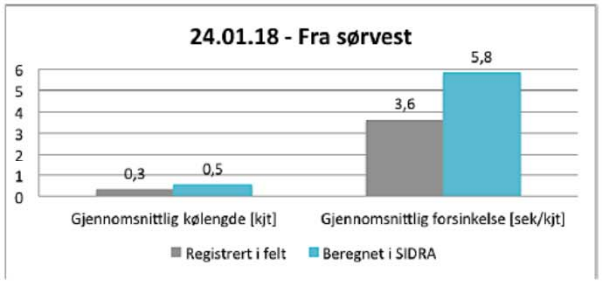
- With 8% grade SIDRA seems to:
- overestimate queue and delay for uphill as critical time gap is increased
- underestimate queue and delay for downhill as critical time gap is decreased



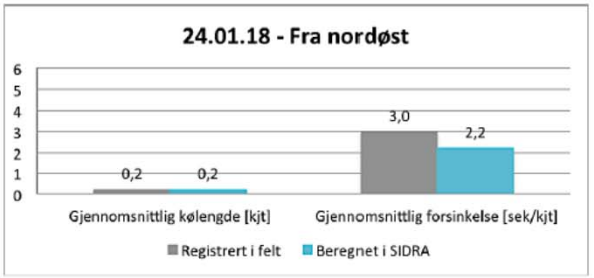

Figur 99: Modelleringsresultat fra sørvest den 23.01.18, med 8 % stigning.



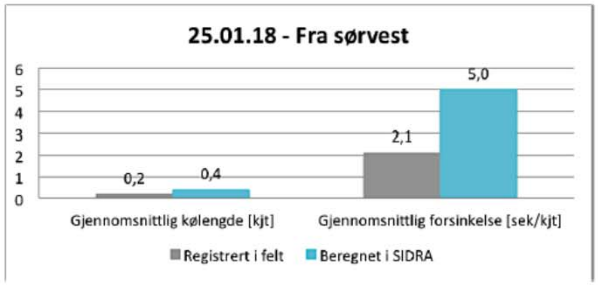

Figur 100: Modelleringsresultat fra nordøst den 23.01.18, med 8 % stigning.



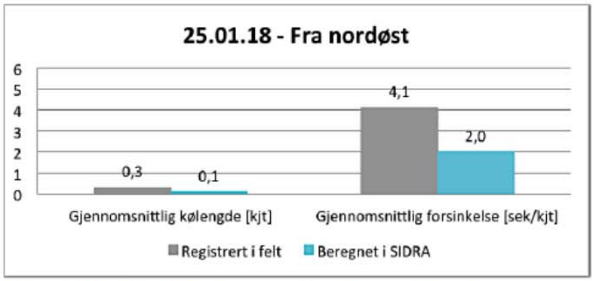

Figur 101: Modelleringsresultat fra sørvest den 24.01.18, med 8 % stigning.




Figur 102: Modelleringsresultat fra nordøst den 24.01.18, med 8 % stigning.



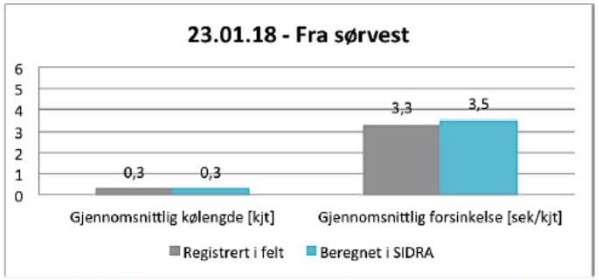

Figur 103: Modelleringsresultat fra sørvest den 25.01.18, med 8 % stigning.



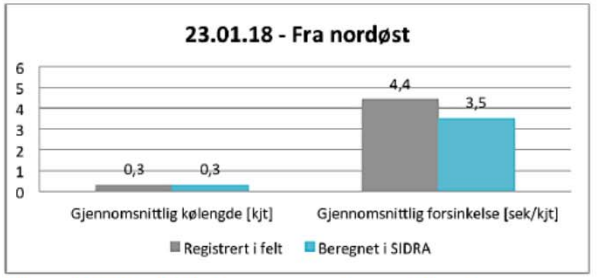

Figur 104: Modelleringsresultat fra nordøst den 25.01.18, med 8 % stigning.

# Observations vs SIDRA calculations

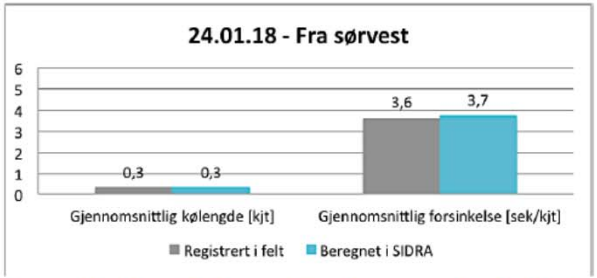
- With 0% grade the results seem to be very good
- The grade correction of critical time gap might not be relevant in the same way for a pedestrian crossing as it will be for conflict between vehicles?



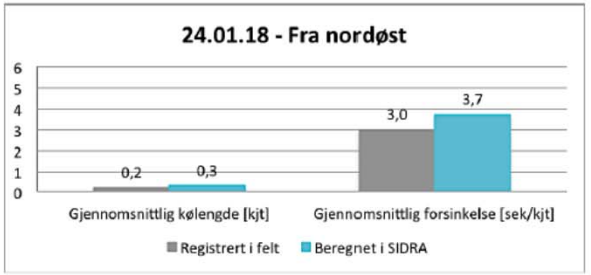

Figur 105: Modelleringsresultat fra sørvest den 23.01.18, med 0 % stigning.



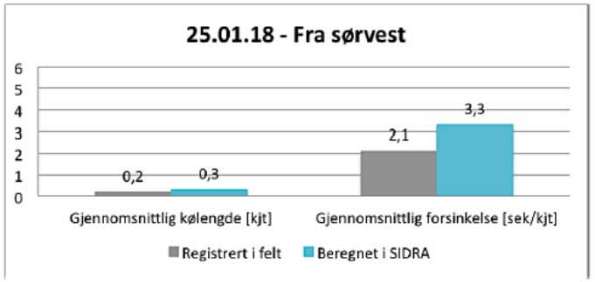

Figur 106: Modelleringsresultat fra nordøst den 23.01.18, med 0 % stigning.



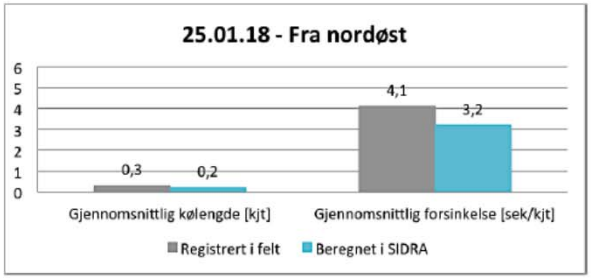

Figur 107: Modelleringsresultat fra sørvest den 24.01.18, med 0 % stigning.




Figur 108: Modelleringsresultat fra nordøst den 24.01.18, med 0 % stigning.

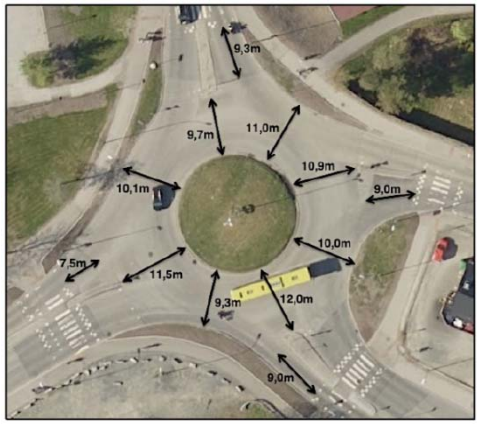


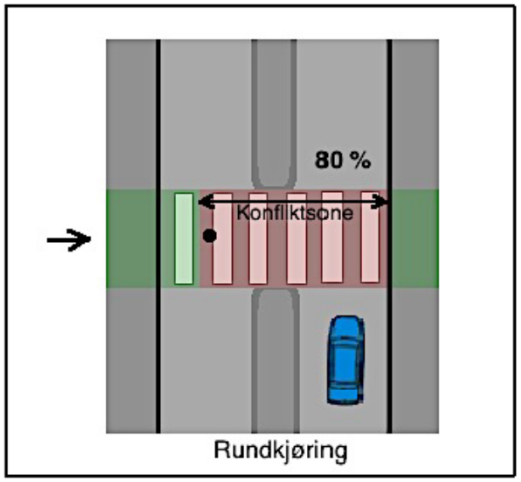

Figur 109: Modelleringsresultat fra sørvest den 25.01.18, med 0 % stigning.

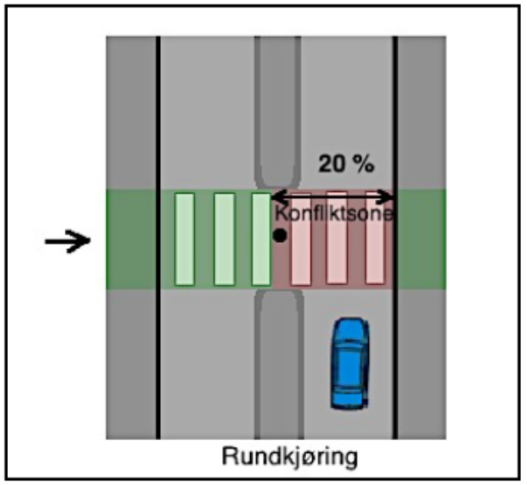


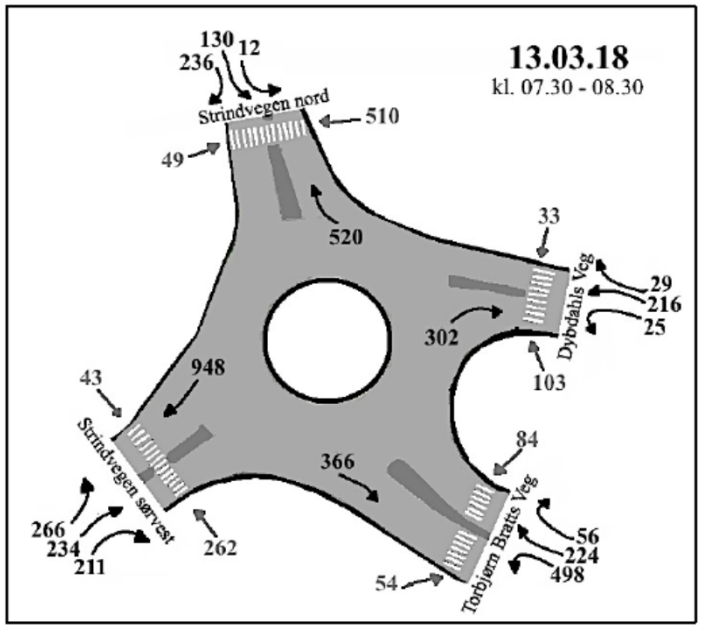

Figur 110: Modelleringsresultat fra nordøst den 25.01.18, med 0 % stigning.

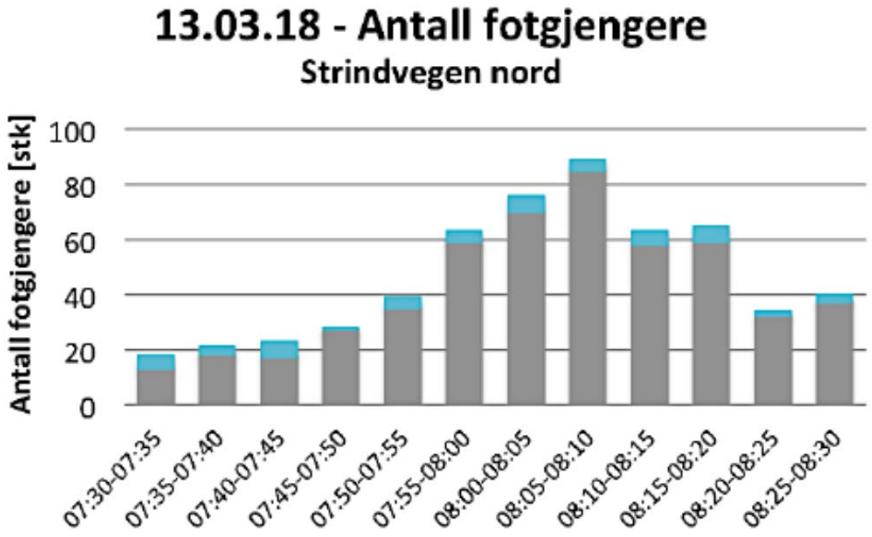
# Detailed observations at Lerkendal in Trondheim



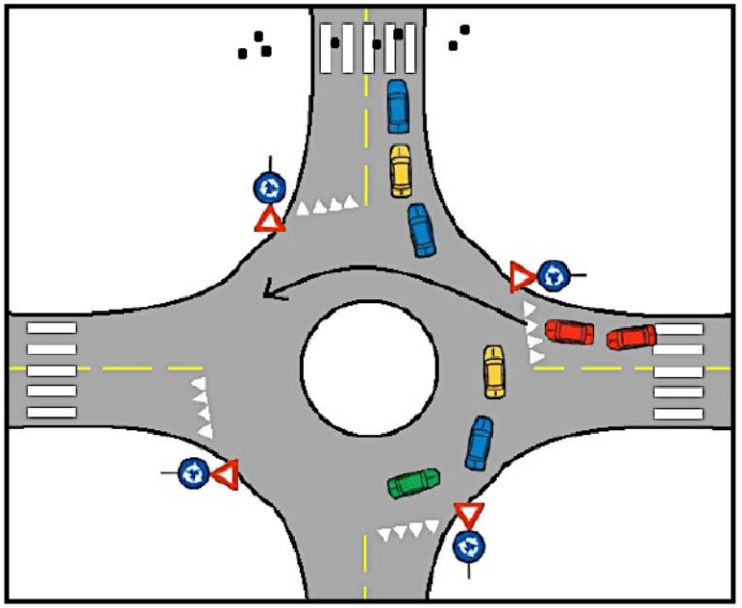



# Driver cooperation and unnecessary blocking

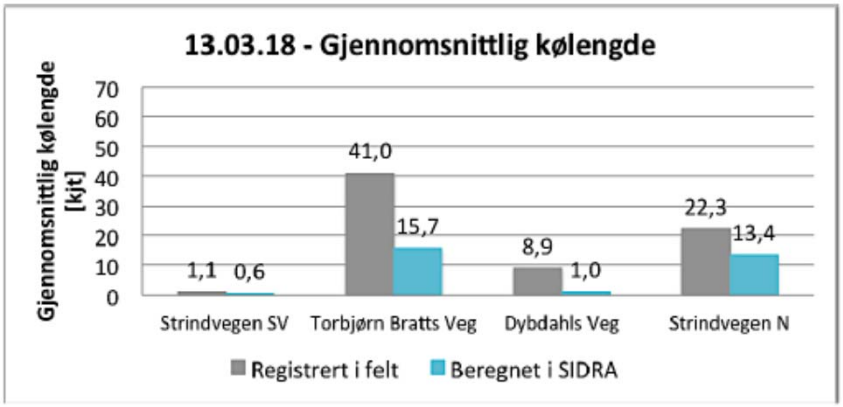
Figur 219: Kjøretøyene lager luke - Strindvegen nord.

Figur 220: Kjøretøyene blokkerer - Strindvegen nord.

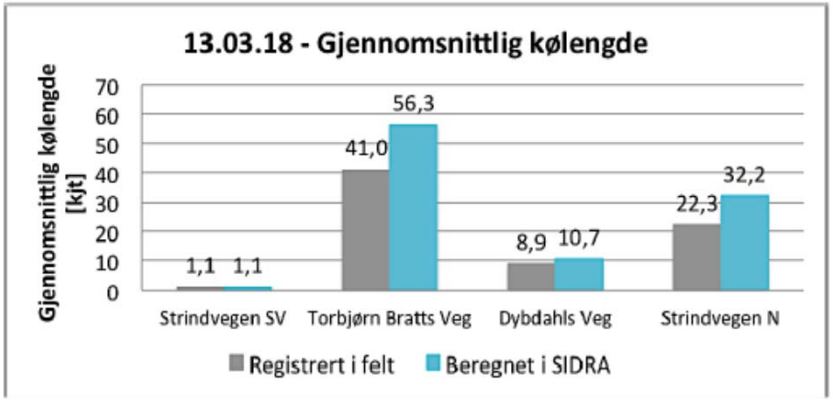
- Cooperation (gaps were made) in 30-50% of the time
- Entries were unnecessary blocked in 50-70% of the time



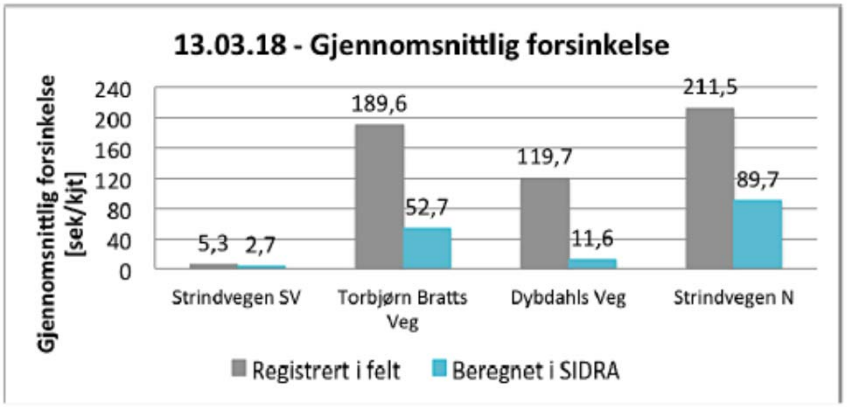
# Observations vs SIDRA calculations



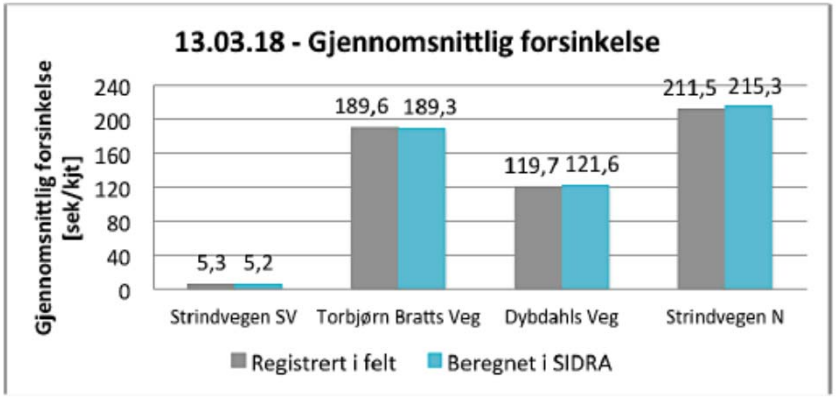

**Figur 296: Gjennomsnittlig kølengde den 13.03.18 - Før kalibrering.**




**Figur 302: Gjennomsnittlig kølengde den 13.03.18 - Etter kalibrering.**




**Figur 298: Gjennomsnittlig forsinkelse den 13.03.18 - Før kalibrering.**




**Figur 304: Gjennomsnittlig forsinkelse den 13.03.18 - Etter kalibrering.**

# Observations vs SIDRA calculations

- With environment factor 1.10 the observed capacity was much less than calculated by SIDRA
- SIDRA seems to underestimate queue and delay with large pedestrian flows
- To get the observed values the environment factor has to be increased to «unrealistic» values between 1.25 and 1.40
- The main reason is probably limited exit capacity and unnecessary blocking
- It is need for further research at roundabouts with high pedestrian flows