Capacity in the Netherlands

Empirical features

Henk Taale

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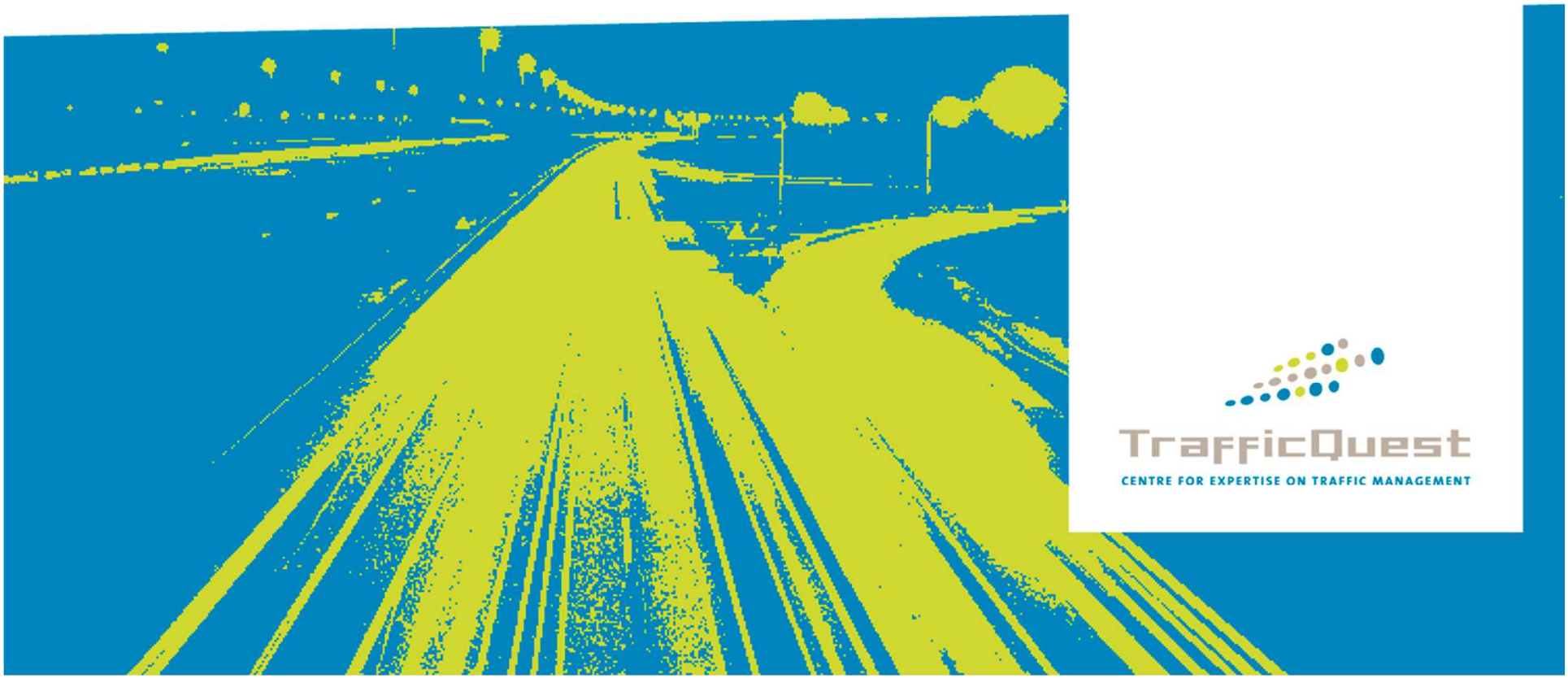


Video ramp metering

Impact ramp metering on capacity

Location	Capacity motorway	Speed motorway
A10 Coentunnel (1st system in NL)	=	+20 km/hr
A10 Coentunnel (4 on-ramps)	+2%	+20 km/hr
A13 Delft-Zuid (1st evaluation)	+5%	Not measured
A13 Delft-Zuid (2nd evaluation)	+4%	Not measured
A12 Zoetermeer	+3%	+3 km/hr
A20 Schiedam-Noord	>	+6 km/hr
A29 Barendrecht	+5%	+3 km/hr
A8 Kolkweg	=	+2 km/hr
A2 Vianen	+5%	+5 km/hr
A2 Boxtel	=	Not measured
A2 Vinkeveen	+2%	+10 km/hr

What is capacity?

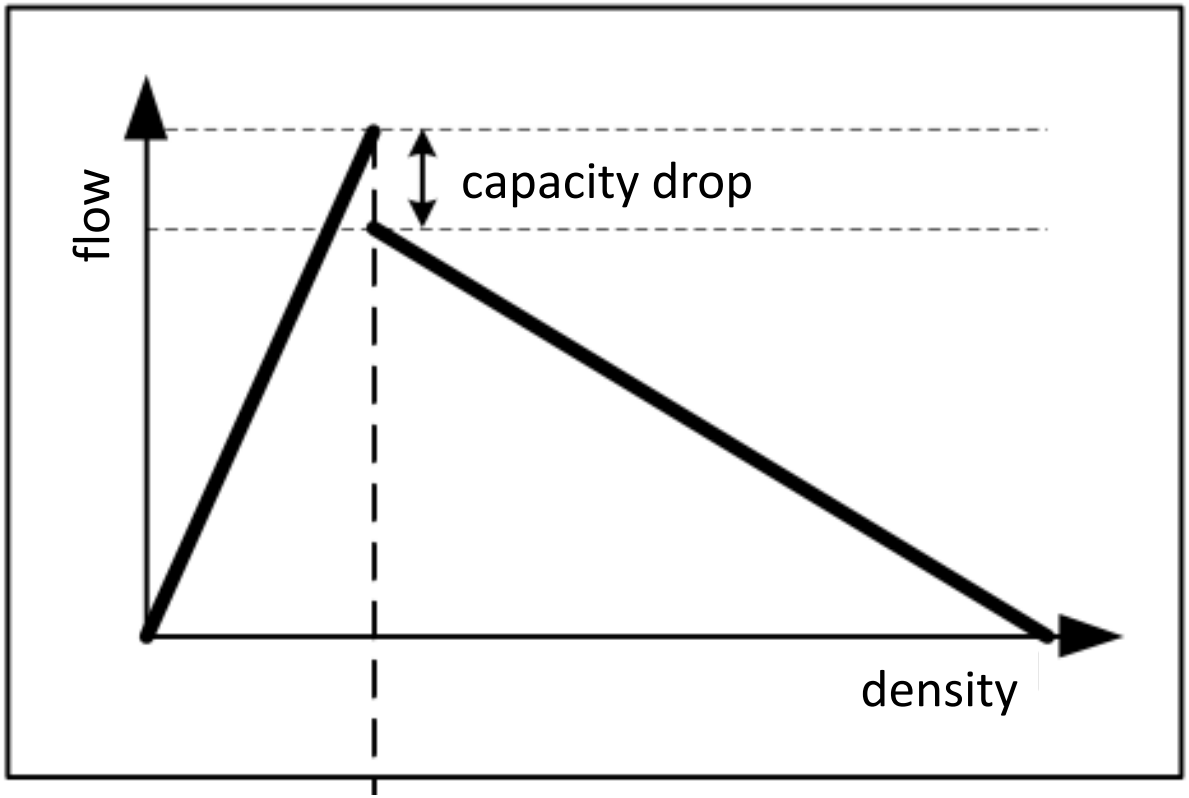
What is capacity?

- Dutch definition for motorways

  The maximum number of vehicles per unit of time that can reasonably pass a cross-section or section of the road during a certain period of time under current road, traffic and traffic management conditions

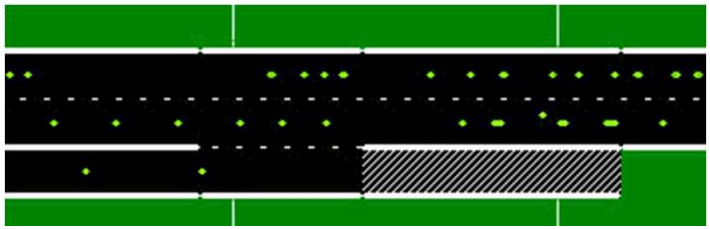
- Aspects
  - Reasonably: stochastic variable
  - Certain period of time: aggregation influences outcome
  - Current conditions: road design, weather conditions, trucks, measures
  - Capacity drop

Capacity drop



Estimating capacity

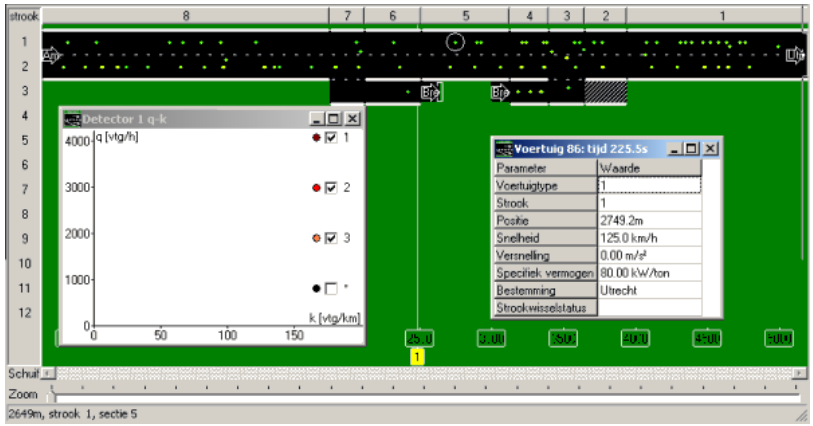
- Rules of thumb
- Simulation
  - FOSIM (Freeway Operations SIMulation)

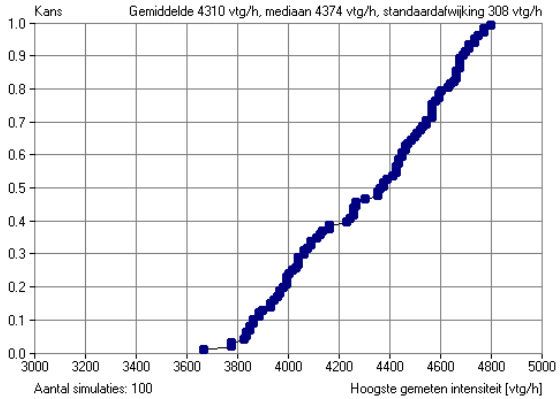


- Data analysis
  - Free flow capacity: Product-Limit method of Brilon
  - Queue discharge capacity: empirical distribution function

FOSIM

- Input geometry and traffic
- Run simulations with different random seeds
- Microscopic model based on theory of Wiedemann (1974)
- Determine distribution and capacity value





Product-Limit method Brilon

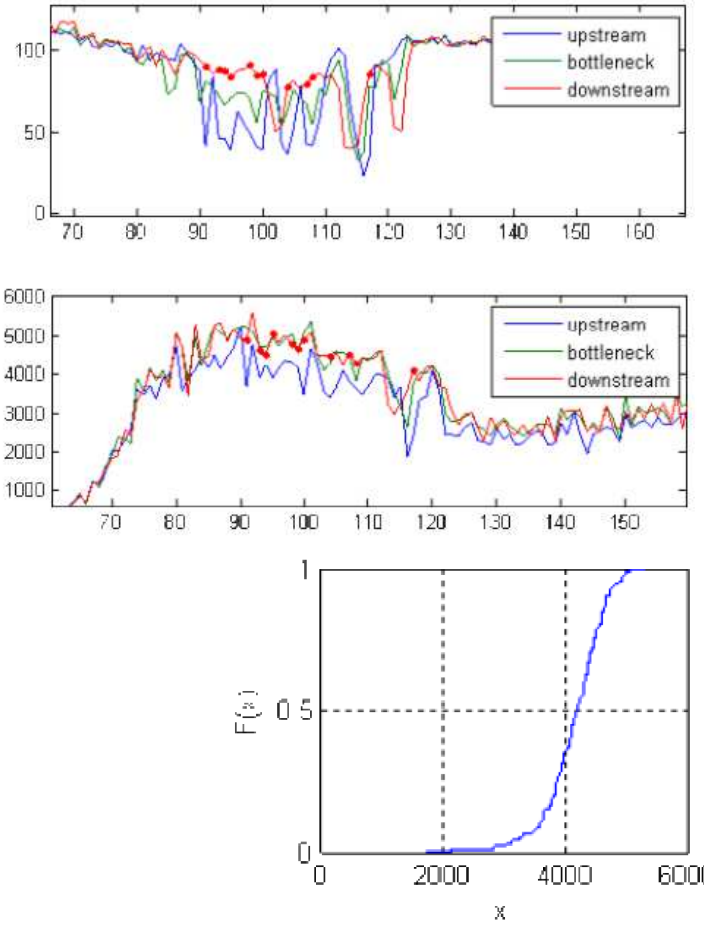
- No empirical distribution assumed
- One observation per congestion period

$$F_c(q) = 1 - \prod_{i:q_i<q} \frac{k_i - d_i}{k_i},\ i \in \{B\}$$

- Where to measure?
- Which criterion for congestion?
- Aggregation of data

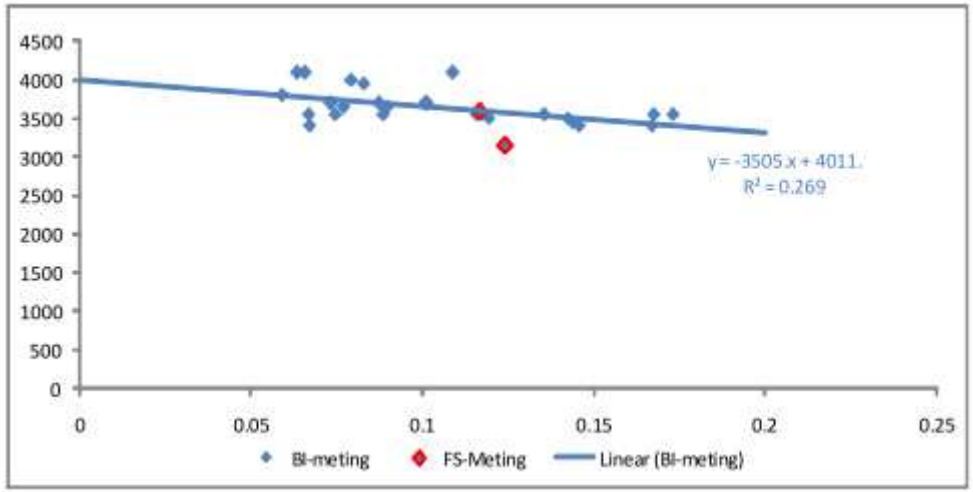
Empirical Distribution Function

- Congestion (speed) upstream
- Flow downstream
- Congestion criterion: 70 km/h
- Distribution
- Median is capacity value



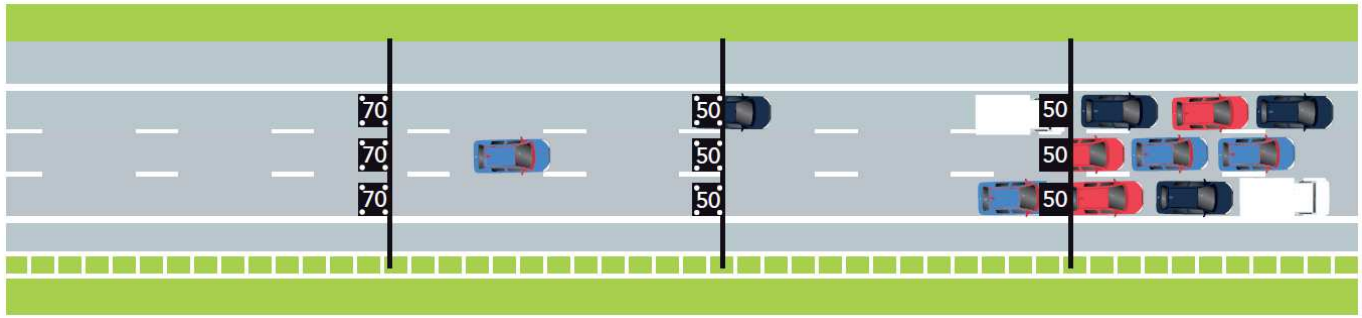
Trucks

- PCU value dependent on traffic situation
- Relation between capacity and % truck
- Value of 2.1



Traffic management and capacity

Measure	Capacity	Delay	# Accidents
Queue tail warning	+2%		-19%
Dynamic speed limits	[-9%, +5%]	[-24%, +36%]	
Ramp metering	+2%	-11%	
Hard shoulder running	+20%	-42%	[-85%, -25%]



Dutch Highway Capacity Manual

- Research on LOS since 1968
- First Dutch HCM in 1999 (CIA)
- Fourth version published in 2015
- Based on extensive measurements and simulations
- Capacity determined on 75 locations using data
  - Average 15% lower queue discharge capacity
  - Range between 0% and 30% lower
- Values for ‘standard’ conditions

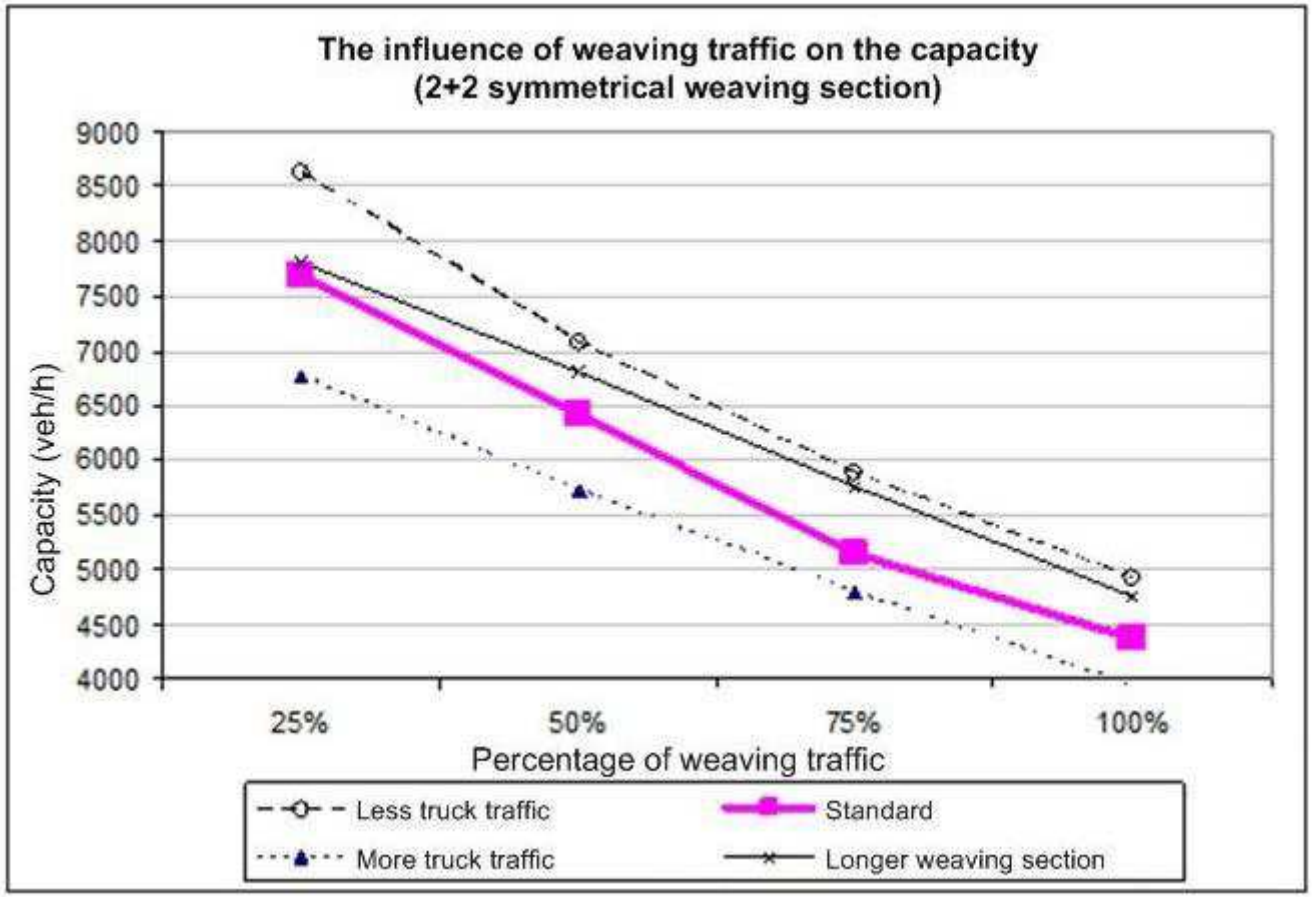
What is standard?

- A maximum speed limit of 100 or 120/130 km/h
- 15% truck traffic
- Design according to Dutch guidelines for freeways
- No large objects near the road side (e.g. noise barriers)
- No distractions caused by objects or events near the road
- No steep gradients (< 2.5%) or less steep over longer distance
- Day light and with dry weather
- Good quality road surface
- MTM equipped, but no other active traffic management measures

Standard capacity values

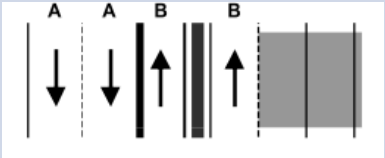
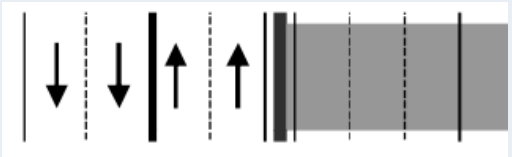
# Lanes	Version 1 (1999)	Version 2 (2002)	Version 3 (2011)	Version 4 (2015)
1 lane (> 1500 m)	1,900	1,900	1,900	1,900
1 lane (<1500 m)	2,100	2,100	2,100	2,100
2 lanes	4,300	4,300	4,200	4,300
3 lanes	6,700	6,700	6,300	6,200
4 lanes	9,000	9,000	8,200	8,200
5 lanes	11.300	11,300	10,000	10,250
6 lanes	13,400	13,400	11,500	12,000
7 lanes				13,500

Weaving and capacity



Deviant conditions

- Rain: light and moderate 0.95, heavy 0.90
- Light: at night with lighting 0.97, without lighting 0.95
- Road works

Configuration	Width	Speed	Capacity
 3-1 system	L 3,00; R 3,25	90 km/hr 90 km/hr	3,400 veh/hr 3,000 veh/hr
 4-0 system	L 1,95; R2,85 L 2,35; R 2,85 L 2,50; R 3,00 L 3,00; R 3,25	70 km/hr 70 km/hr 70 km/hr 90 km/hr	2,600 veh/hr 2,800 veh/hr 3,000 veh/hr 3,400 veh/hr

Applications of capacity

- Planning
  - Analysis of future bottlenecks
  - Design
- Modelling
  - Transport models
  - Traffic models
- Operations
  - Planning of road works
  - Detours
  - Traffic state prediction (incidents)

What about capacity in cities?

- Intersection type
  - Signalised
  - Roundabout
  - Give way
- Intersection aspects
  - Signal control plan
  - Distance between intersections
- Vehicles or travellers?

Contact

Henk Taale
Rijkswaterstaat, TrafficQuest & Delft University of Technology
E-mail: henk.taale@rws.nl
Tel. +31 88 7982498

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