Seminar 2+1

"Friendly and Safe for Users - 2+1 Lane Case Study"

Experiences from Germany

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Warsaw, 28/11/2012

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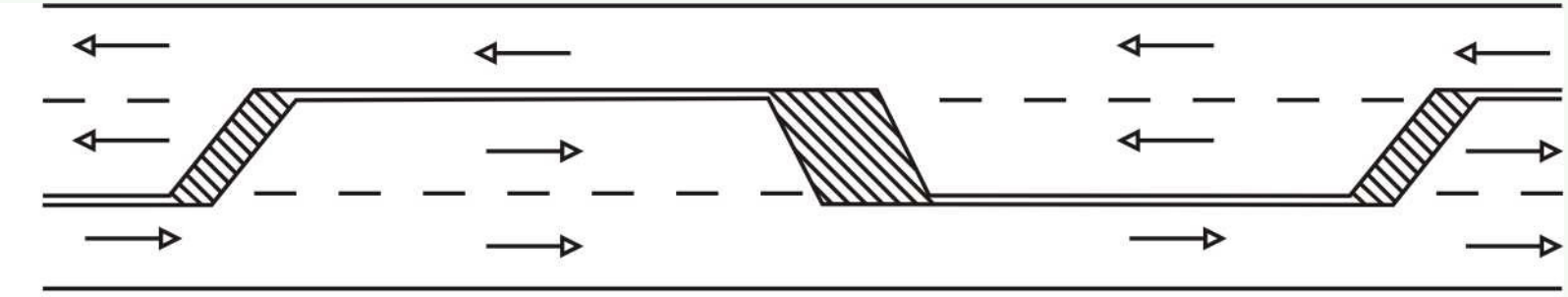
What are the characteristics of a “2+1” road?

- single carriageway with 3 lanes
- continuous alternating passing lane
- both directions are separated (central reserve)
- along a longer distance regardless of topography

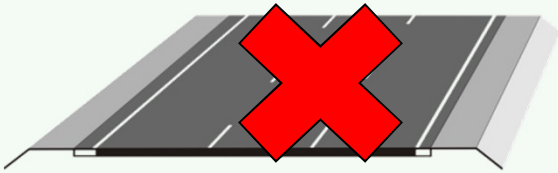
Cross Section Design

Road Layout

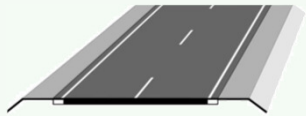


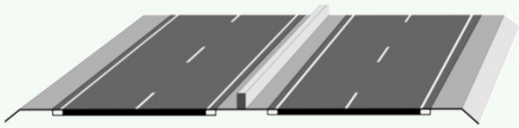
Historical Review

- since ~1930 “three lane roads” were used in different European countries
  - high risk on head-on crashes
  - no significant better traffic flow
  - **not** implemented in Germany (BMV, 1963)



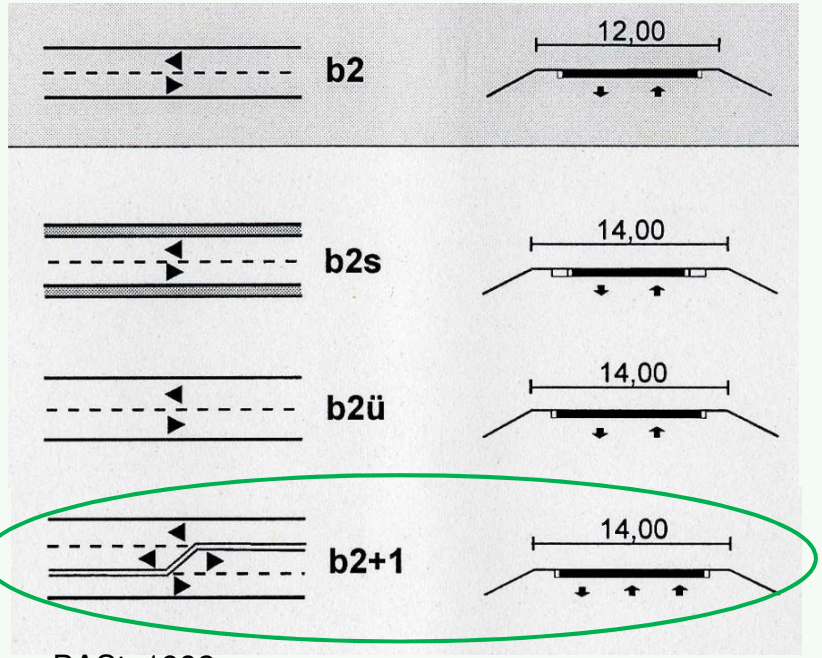
- until 1980
  - only 1+1 and 2+2 carriageways in Germany
  - 1+1: insufficient traffic flow at ADT ≥12.000 veh/d
  - 2+2: reasonable from ADT ≥18.000 veh/d





- since 1980
  - first field studies with “2+1” roads
  - intensive research with “intermediate cross sections”

Intermediate Cross Sections



BASt, 1992

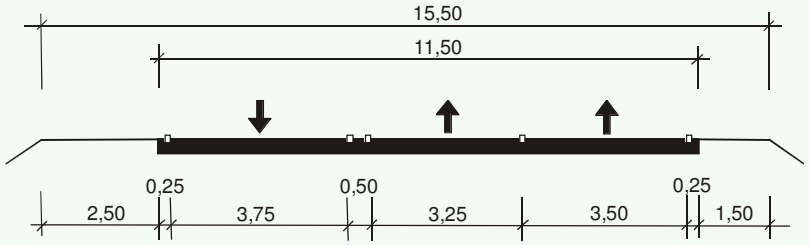
standard 1+1 cross section

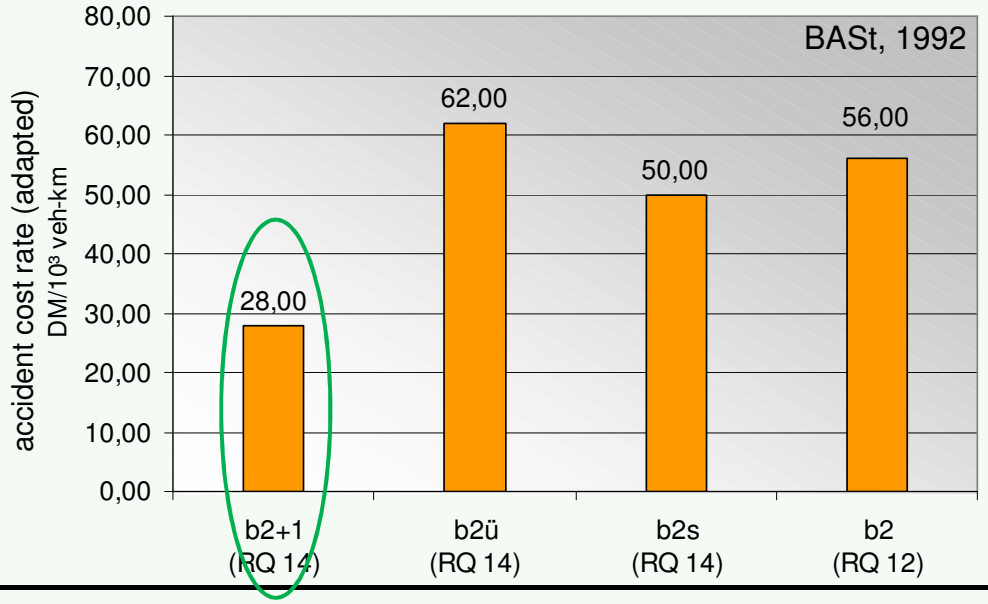
1+1 with 1.50 m hard shoulder

1+1 with lane width of 5.00 m

2+1 with alternating passing lane

Design Guideline RAS-Q 1996





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- RAL ... Guideline for Rural Road Design

- Design principles:

  "standardized roads"
  - only a few road types (4 design classes)
  - as uniform as possible within the same design class
  - noticeable difference to other design classes
  - road marking as the unique identifier

  "self-explaining roads"
  - road design in a way that the driver acts correctly
  - well suited elements of alignment, cross section and of intersections

2+1 in coming German design guidelines

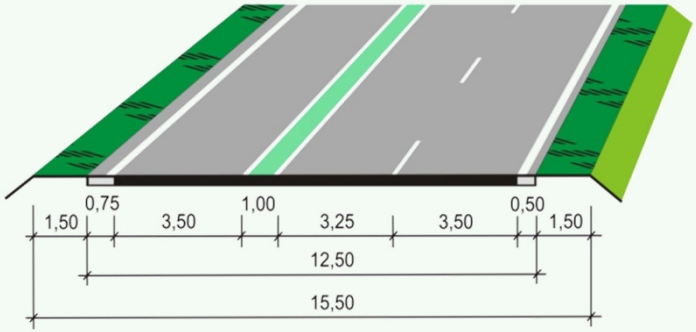
- Approach to “self-explaining” and “standardized roads”
  - well suited design elements of:
    - alignment
    - junctions and
    - cross sections
  - implementation of tight specification for different roads functions

- New design classes:

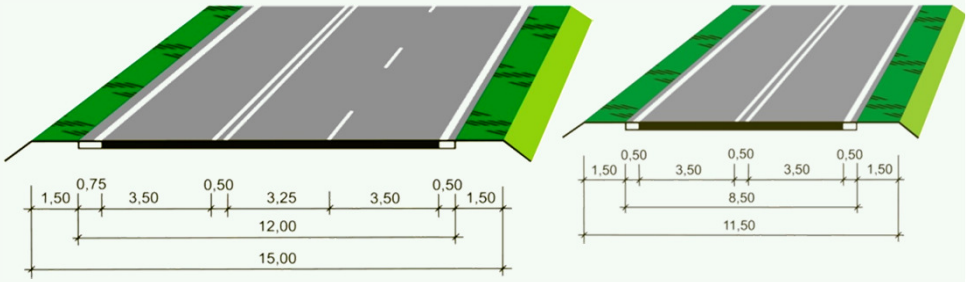
road category	*road function*	*aimed travel speed*	*design class*
LS I	long distance traffic (40-160 km)	80-90 kph	EKL 1
LS II	national traffic (10-70 km)	70-80 kph	EKL 2
LS III	regional traffic (5-35 km)	60-70 kph	EKL 3
LS IV	local traffic (up to 15km)	50-60 kph	EKL 4

2+1 in coming German design guidelines

Design Class 1

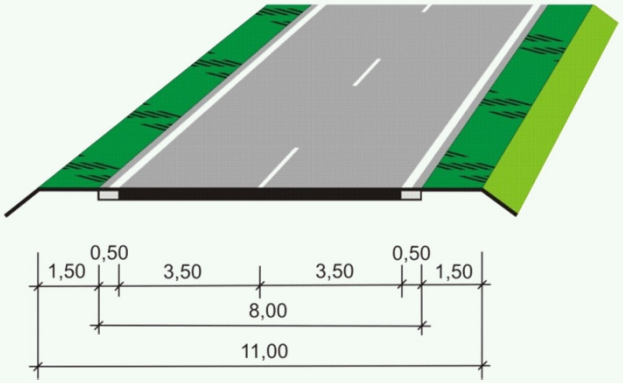


Design Class 2

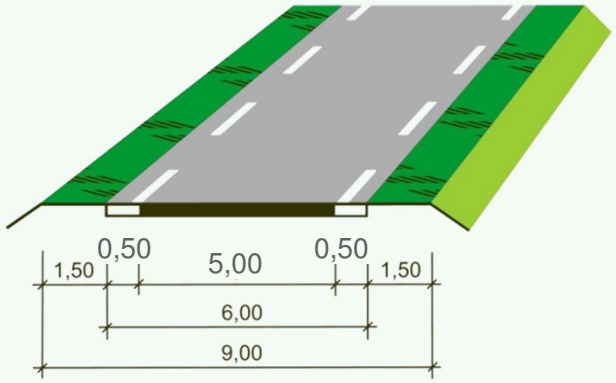


road marking as the unique identifier! → every time visible

Design Class 3



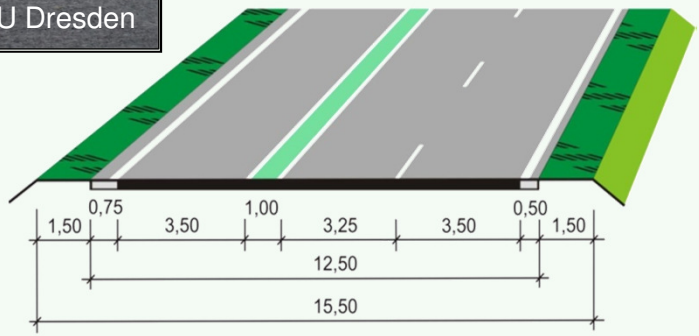
Design Class 4



Design Class 1

long distance traffic
(40-160 km)

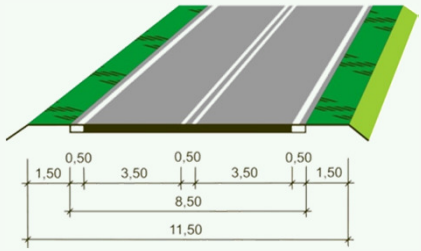
ADT:
up to 22.000 veh/d

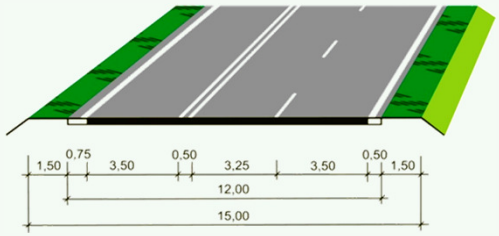


Design Class 2

national traffic
(10-70 km)

ADT:
8.000 veh/d up to 15.000 veh/d

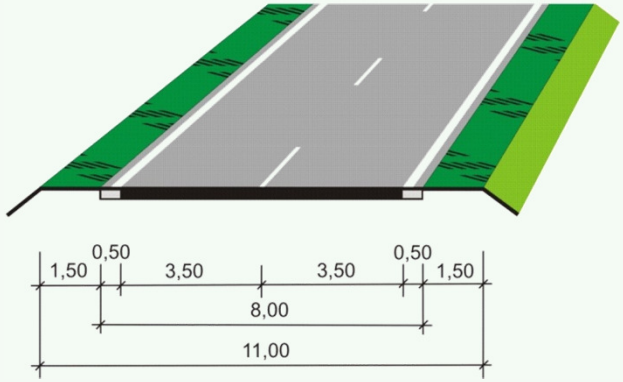




Design Class 3

regional traffic
(5-35 km)

ADT:
up to 13.000 veh/d

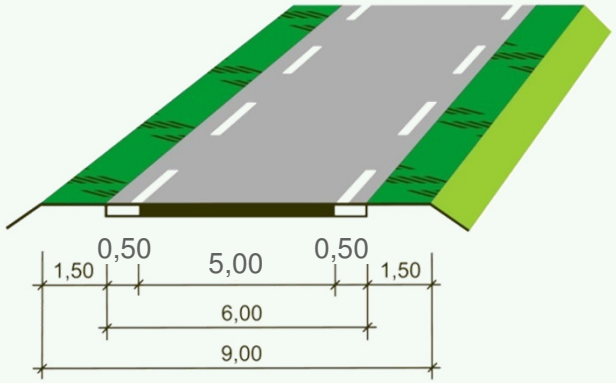


Design Class 4

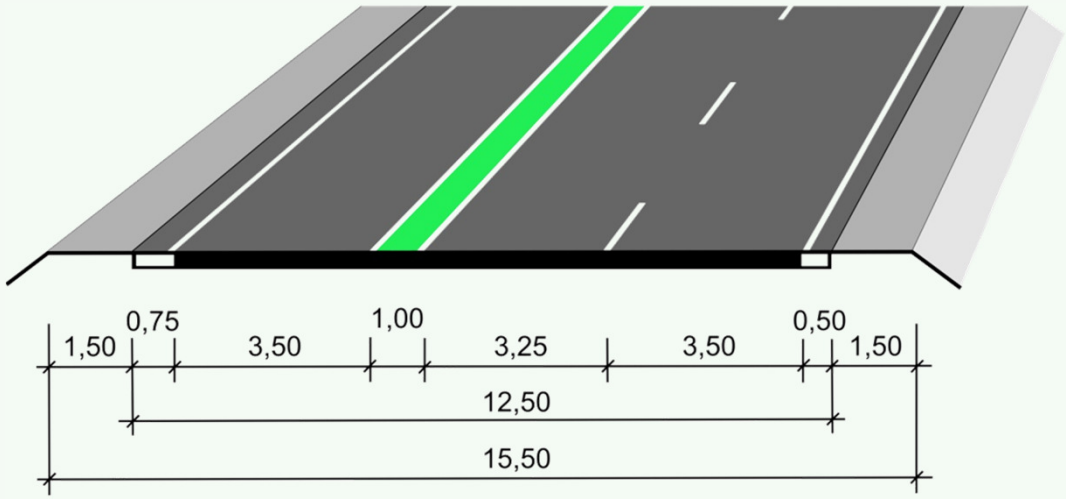
local traffic
(up to 15km)

ADT:
up to 3.000 veh/d

HGV's: max 150 veh/d



Principles of “2+1” cross section

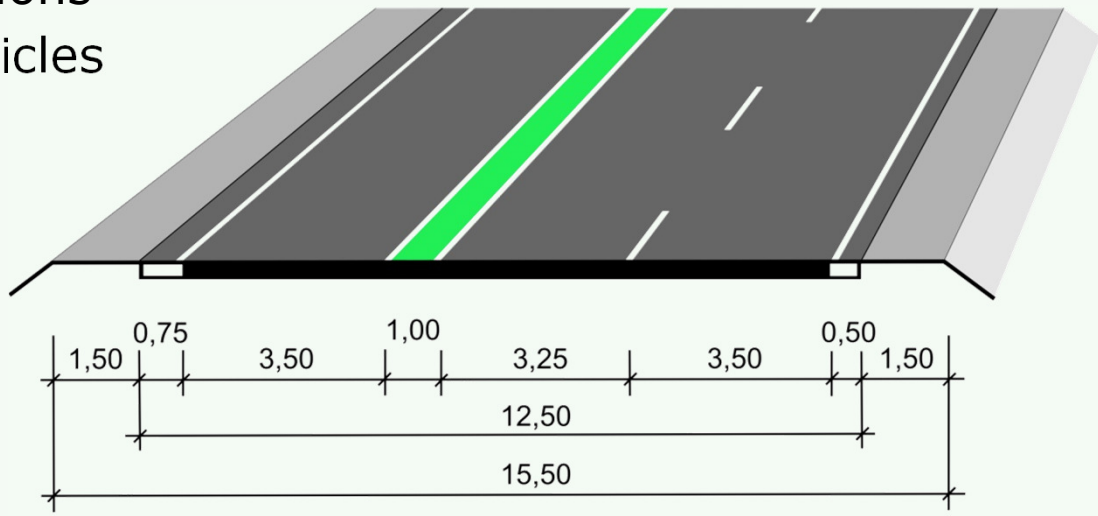


dimensions:

- driving lanes: 3.50m
- passing lane: 3.25m
- central reserve: 1.00m
- hard shoulder: 0.75m and 0.50m
- road verge: 1.50m (stabilized)

Principles of "2+1"

- continuous alternating passing lane
- 40% safe overtaking opportunities in each direction
- passing lane length 1.000 m to 2.000 m
- directions are separated by a median reserve (green colour)
- emergency lay-by's in the one lane direction (each 1.000 m)
- along a longer distance
- ADT from ~12.000 veh/d up to ~22.000 veh/day
- only level free intersections
- restriction to motor vehicles



Alignment

- radii: ≥ 500 m
- slope: ≤ 4 %
- crest: ≥ 8.000 m
- sag: ≥ 4.000 m

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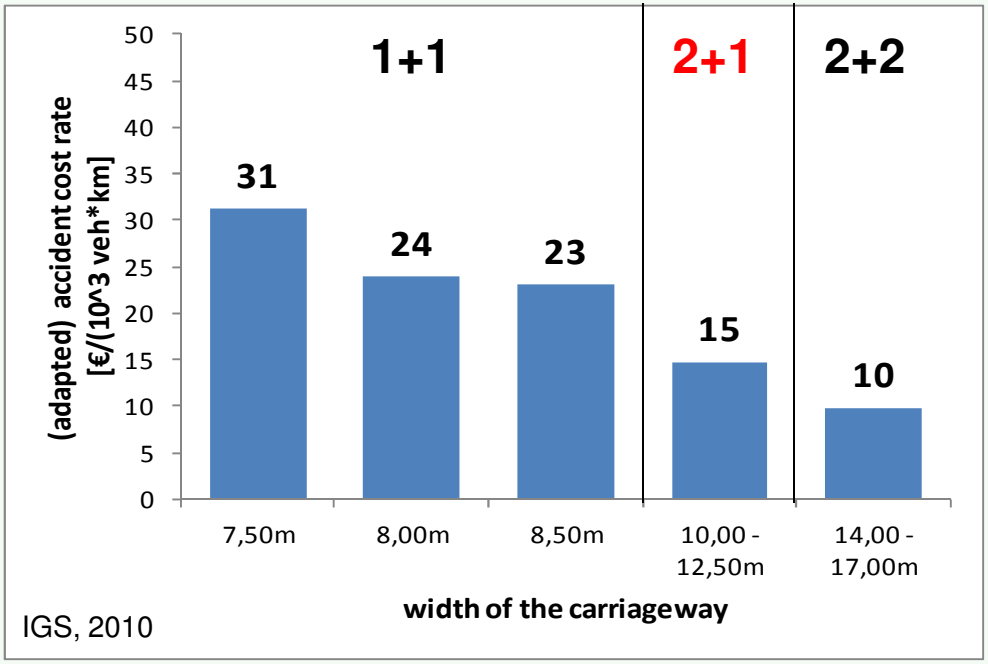
Road Safety on 2+1 roads

2+1 road safety in general (Meewes, 1984; Brannolte, 1992; GDV, 2002; Weber, 2005)

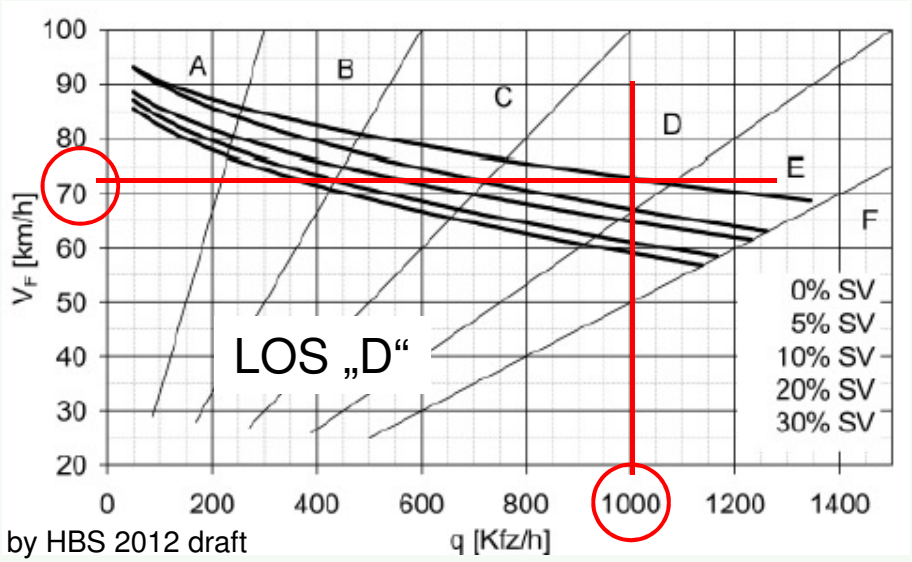
- high level of safety
- lowest accident cost rate of all single carriageway roads
- low number of accidents (especially head-on crashes)
- most accidents in lateral direction while merging in front of the ghost island

Most accidents caused by:

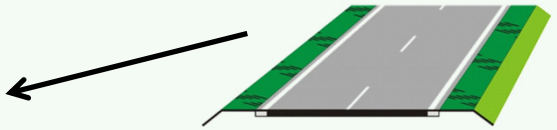
- excessive speed
- bad weather conditions
- crossing animals (game)
- overtaking even if it is prohibited (rarely)

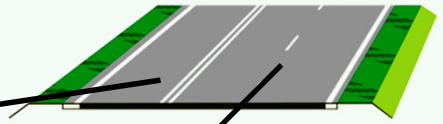


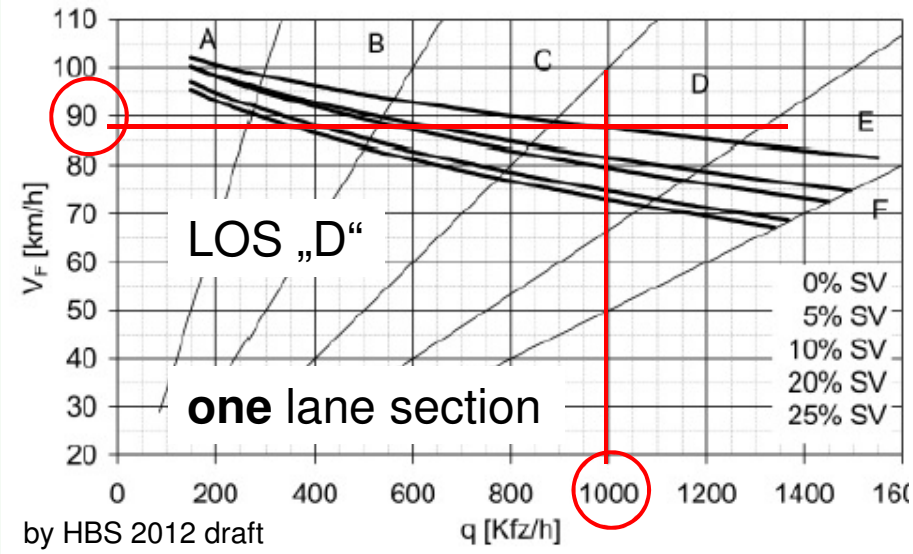
Traffic Flow on 2+1 roads



by HBS 2012 draft







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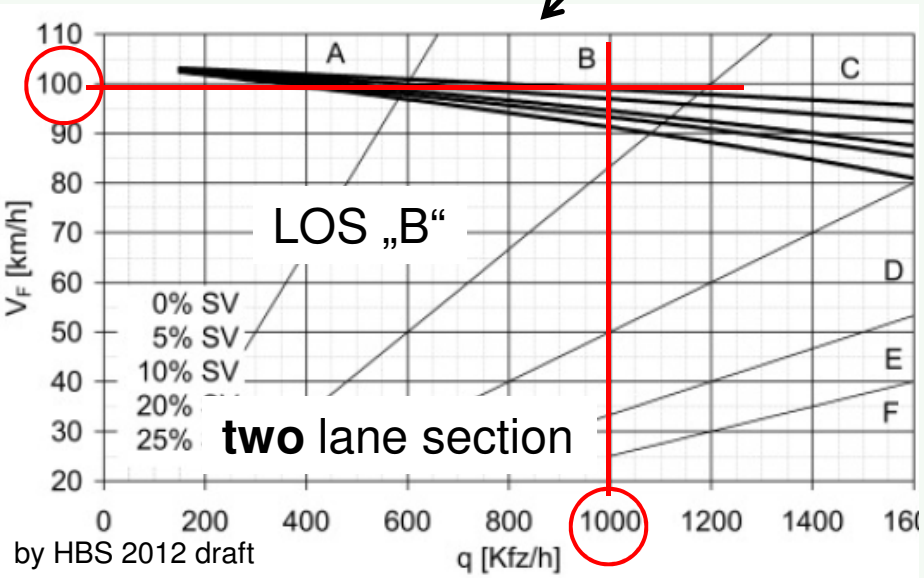
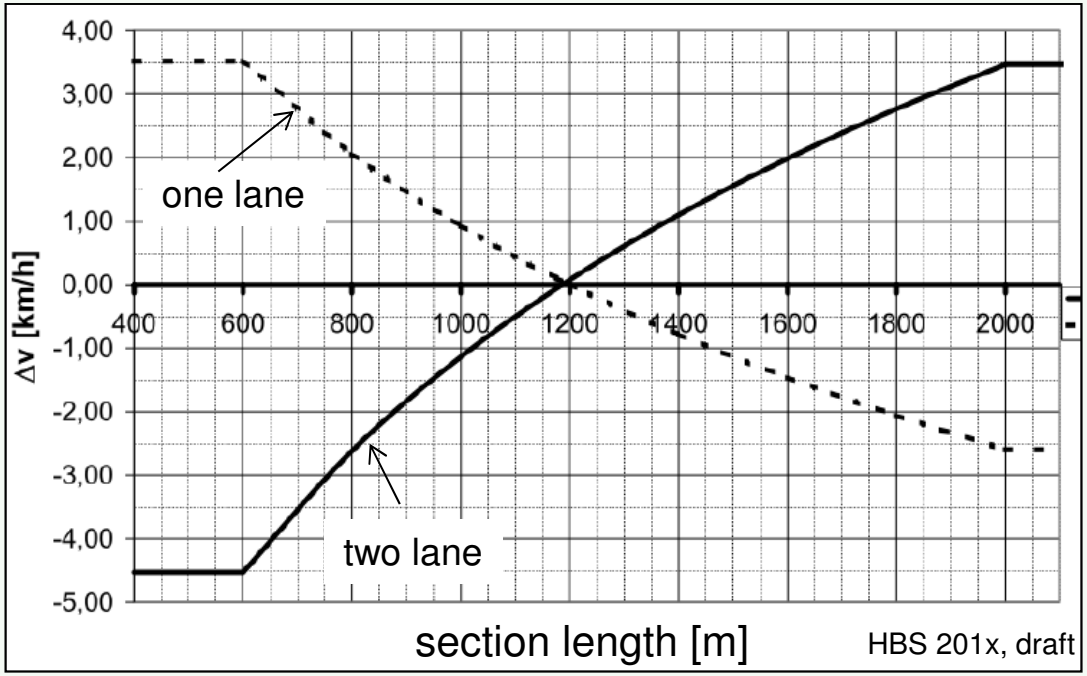


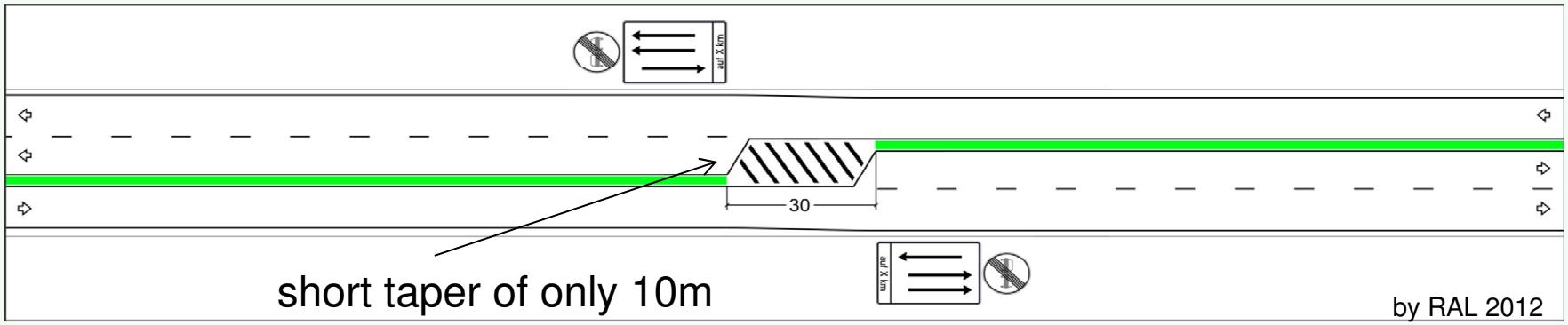
by HBS 2012 draft

Traffic Flow on 2+1 roads

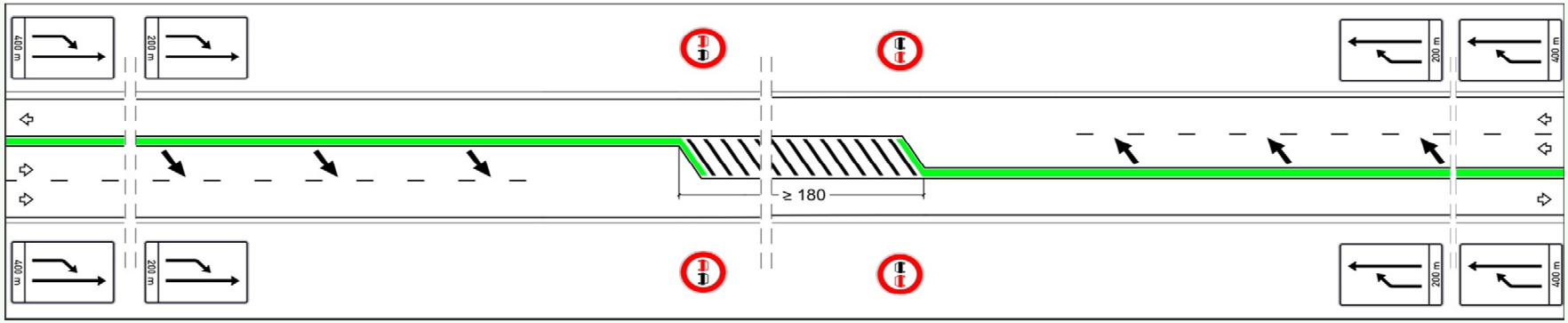
- values can be reached if:
  - 40% safe overtaking opportunities in each direction
  - a passing lane length of 1.200 m
- velocities in one lane sections depend mainly on the share of HGV's
- level of speed in one and two lane sections are influenced by section length



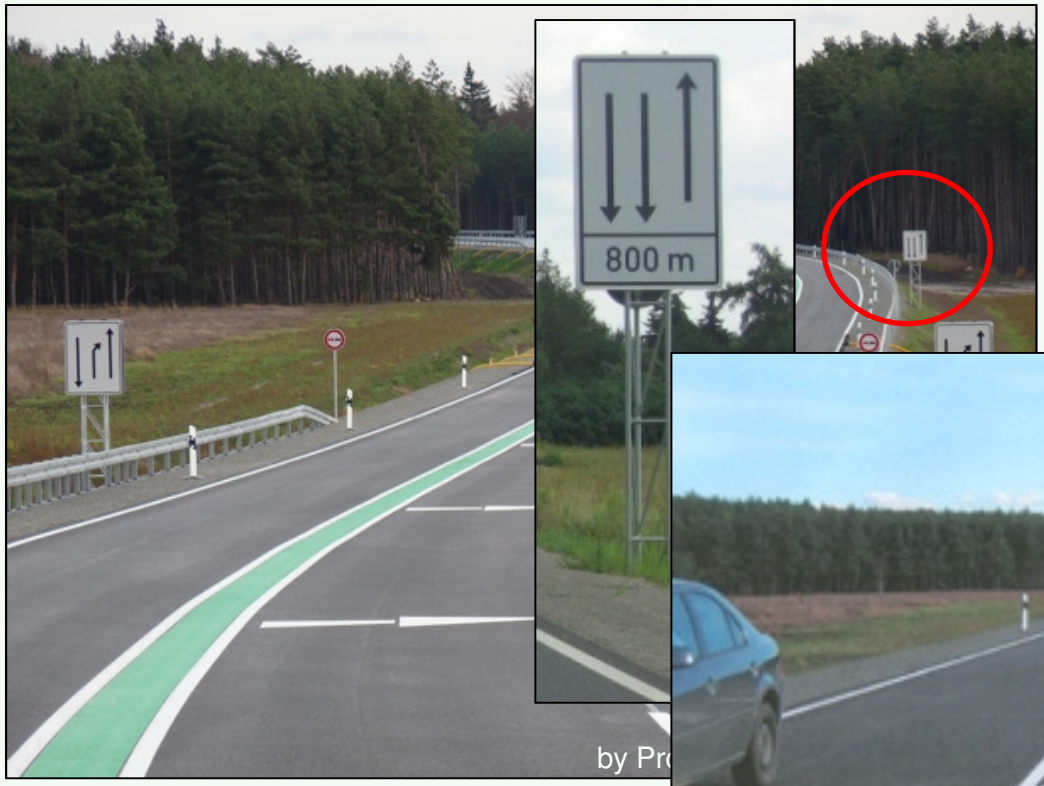
- non-critical changeover (vehicles are not heading towards one another)



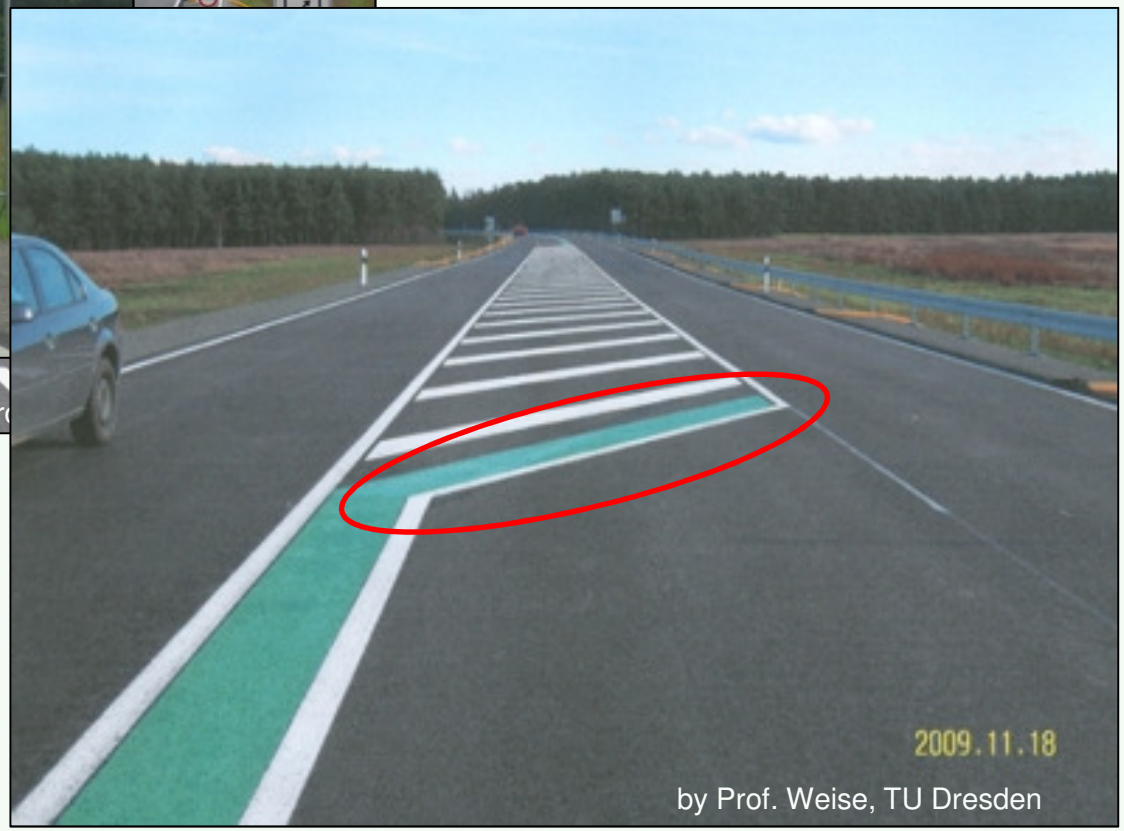
- critical changeover (vehicles in the middle lane are heading towards one another)



Changeover - Marking and Signage



signs are showing the distance to the next passing lane



“barrier effect” to reduce driving over critical island

Changeover - Marking and Signage

large arrow marking:

- indicates passing lane end
- better visibility
- supports correct driving behaviour

Dividing Strip Design

Research about different dividing strip designs (by TU Dresden, 2012)
before/after-comparison of:

- road safety
- driving behaviour
- driver acceptance
- maintenance and costs

Research results (by TU Dresden, 2012)

- road safety
  - number of accidents too low to get sure results
  - no differences between all investigated designs
  - red colour not suitable (used for cycle ways in general)
- velocities (85%-speed)
  - vertical reflectors: decrease by up to 9 kph
  - all other designs: only minor changes
- acceptance
  - very high perception of colour marking
  - acceptance of vertical reflectors was higher than colour marking
- maintenance and costs
  - angular design has lowest costs in construction
  - reflectors not recommended (expensive, winter maintenance)

- only level free or grade separated junctions
  - better road safety
  - meet the standards for average travel time

- standard junction design (level free/ grade separated)

Maintenance

- durability of dividing strip marking similar to standard marking
- vertical reflectors expensive and not resistant against winter maintenance

- winter maintenance
  - more runs are necessary to clear the road from snow
  - additional snow plough

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"2+1" - Conclusion

Where are the **advantages** of a 2+1?

- significant higher road safety (compared to 1+1)
  - safe overtaking opportunity
  - lower pressure on overtaking
  - lower ACR of 30 to 50%
  - significant lower number of head-on crashes
- better traffic flow
- higher average travel speed (junction design!)
- no overtaking sight distance needed
- lower costs of construction compared to 2+2
- lower environmental impact compared to 2+2

"2+1" – Conclusion

Where are the **disadvantages** of a 2+1?

- high velocities in passing lanes
- separate network for slow moving traffic necessary
  - additional ways for cyclists
  - additional ways for agricultural vehicles
- only level free and grade separated junctions
  - expensive
  - more space needed
- higher costs for winter maintenance

currently in progress:

- official release of the German Rural Road Design Guideline (RAL) by the Ministry of Transport

- instructions how to adapt the existing road network to design classes according to the new rural road design guideline (RAL)

Seminar 2+1

"Friendly and Safe for Users - 2+1 Lane Case Study"

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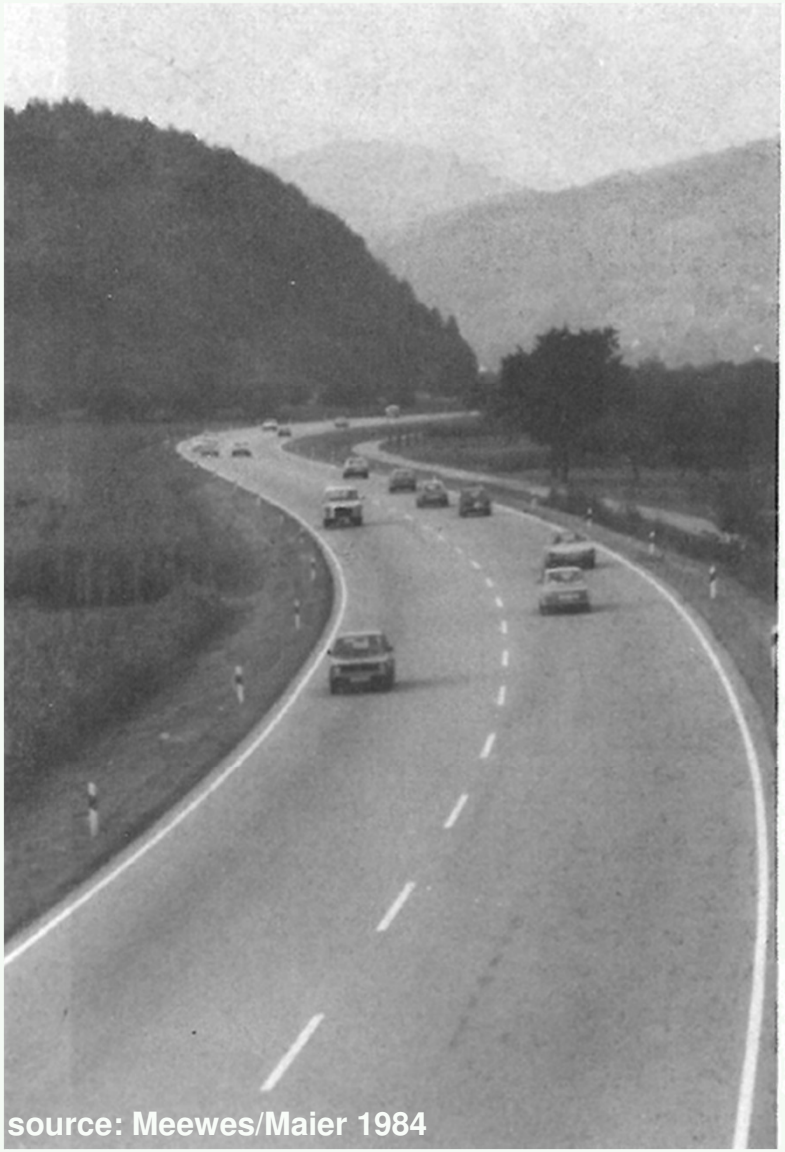
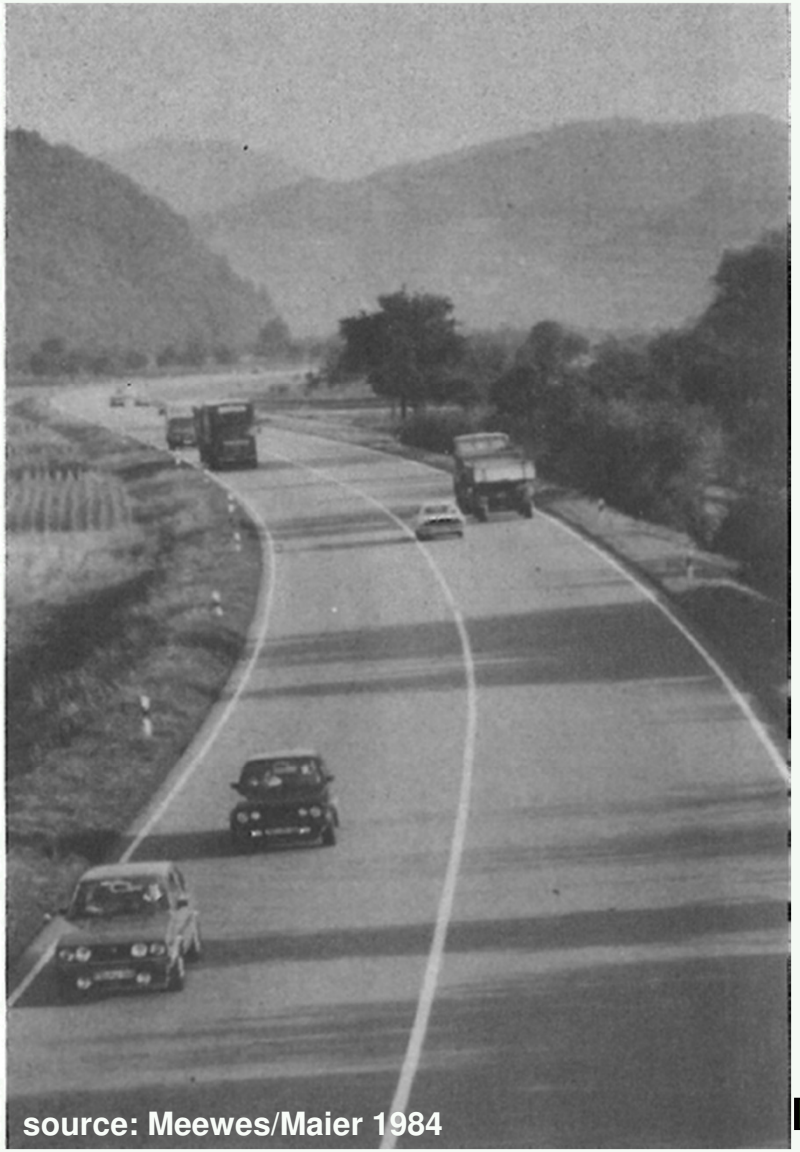
b2ü cross section



source: Meewes/Maier 1984

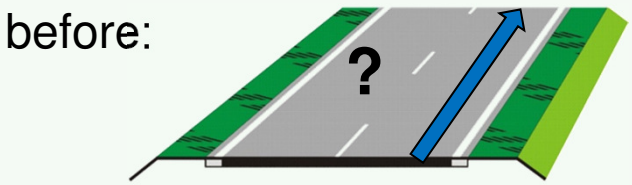


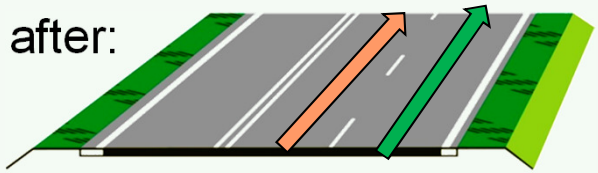
source: Meewes/Maier 1984

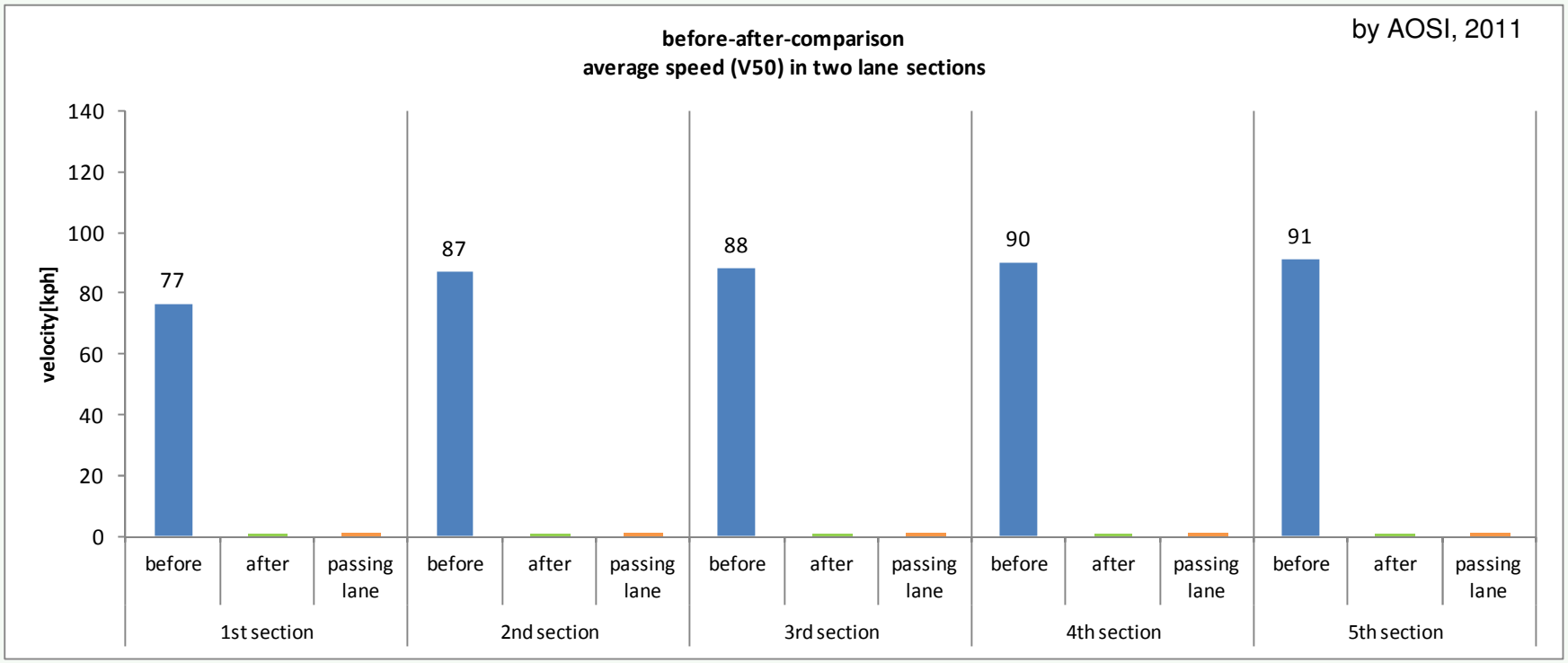
emergency lay-by

Velocities on 2+1 roads

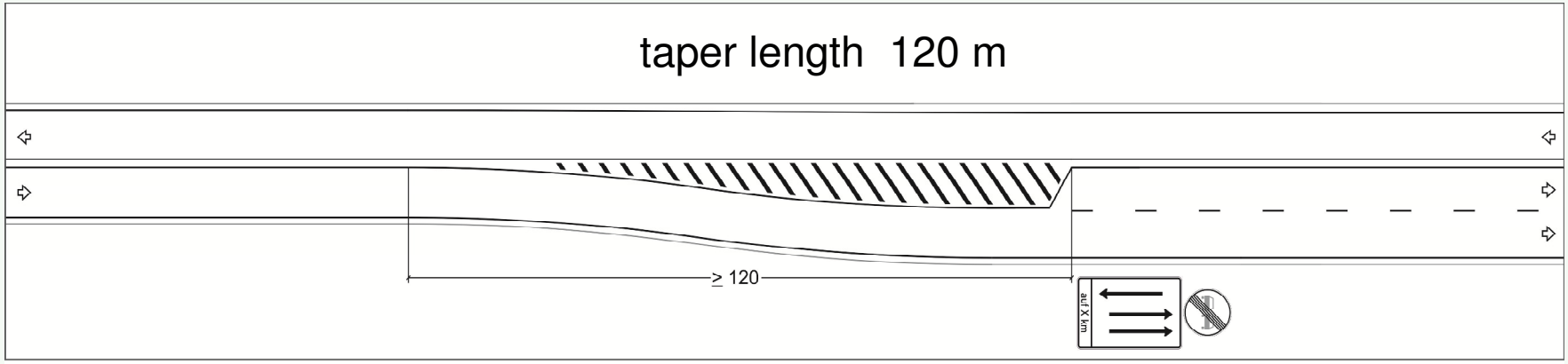
- velocities in two lane sections (passing lanes) are often above the legal speed limit (by up to 20 km/h in average)



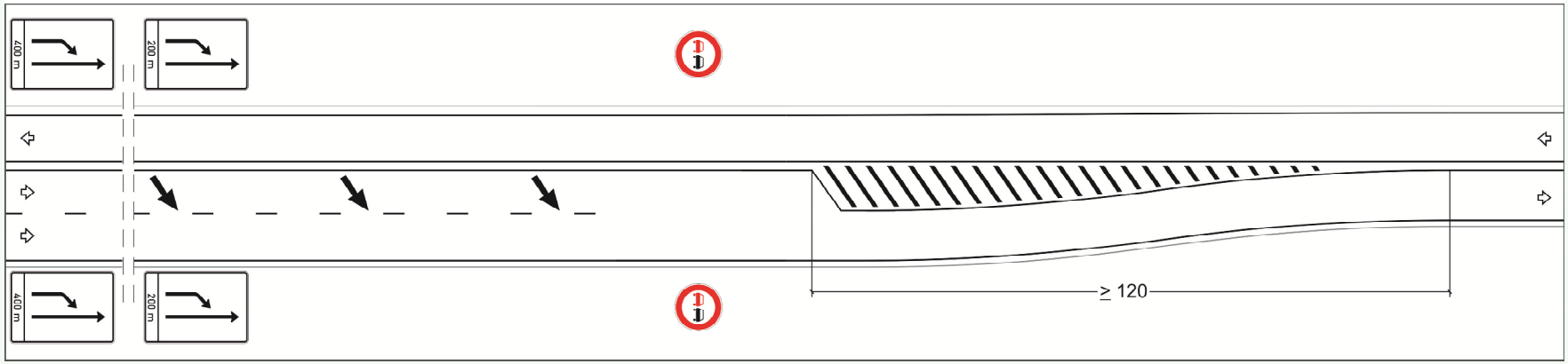




- begin of a 2+1 Section



- end of a 2+1 section



Problems EKL 1