Support for Implementing Measures for the South East Core Regional Transport Network Multi Annual Plan (EuropeAid/125783/C/SER/MULTI)

Safer design of interurban roads and motorways

by

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Overview about content

1. Function of the Road
2. Design - and Operation elements
3. Cross section (incl. drainage issues)
4. Alignment
5. Intersections
5. Some additional measures

1. Road Function

1. Road Function

- Effects of the project or existing road on the surrounding road network
- Correspondence of road function and the desired use of the road

Functional classification

- Modern road traffic needs a road network
- Modern network needs a sensible structure
- Important decision at the start of every investment into the traffic facilities
- Interurban or urban road?

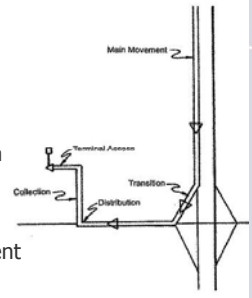


Exhibit 1-1. Hierarchy of Movement
Source: AASHTO

Conclusion: different needs – different solutions!

- Mixed function with vulnerable road user is a big challenge
- difficult situation to increase the road safety

2. Design and operating elements

2. Design and operating elements

- Avoid high absolute speed,
- Avoid differences in direction,
- Avoid Unpredictable situations,
- Avoid excessive speed differentials,
- Peculiarities of project: Rehabilitation and
- major maintenance,
- Target: stepwise safer road network

Design and operating elements

continue

- Specific traffic composition characteristics?
- Design speed suitable for the road category?

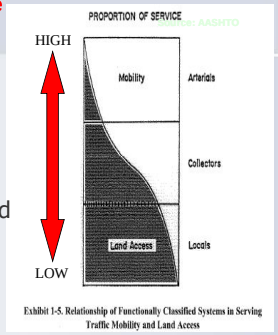
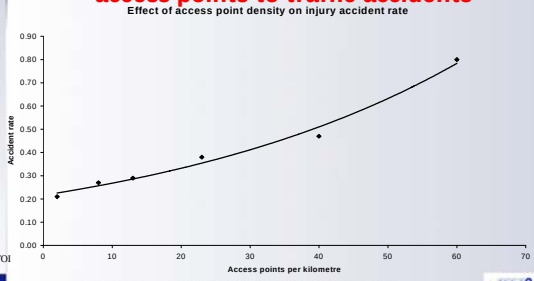


Exhibit 1-5. Relationship of Functionally Classified Systems in Serving Traffic Mobility and Land Access

Focus on road safety:

The Influence of the number access points to traffic accidents



source:TOI

3. Cross section

3. Cross section

- Is the cross section design suitable for the traffic volume and traffic composition?
- Contradiction long distance transport – mixed traffic
- Cross section different types, decision on the basis of the traffic volume, composition and function...

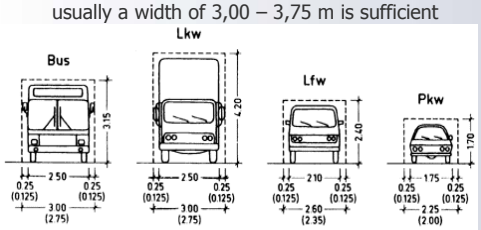
Source: AASHTO

Choice of the safest cross section

Attend to needed traffic area!

Example geometry for bus, trucks, cars, width of the lane depend on speed and purpose,

usually a width of 3,00 – 3,75 m is sufficient



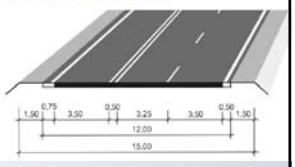
Interurban Highway - Regular Cross sections

experience from Germany

One carriageway cross section

- special cross section with Overtaking lanes

Regelquerschnitt für Straßen der EKL 2



source: Draft RA

Interurban Highway - Regular Cross sections

experience from Germany

Regelquerschnitt für Straßen der EKL 3

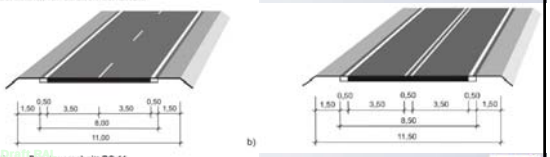


Bild 4.3-2: Regelquerschnitt RQ 11

Interurban Highway - Regular Cross sections

experience from Germany

Two carriageway cross section for rural roads, expressways and for motorways

Regelquerschnitt für Straßen der EKL 1 – EKL 3 mit sehr hohen Verkehrsbelastungen

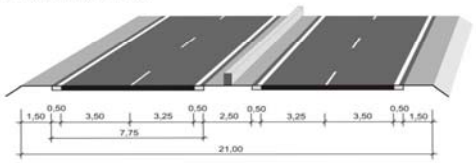
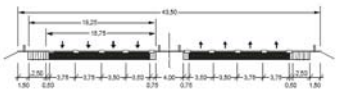


Bild 4.3-5: Regelquerschnitt RQ 21

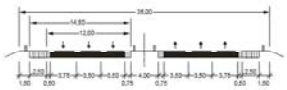
source: Draft RAL

Motorway - Regular Cross sections

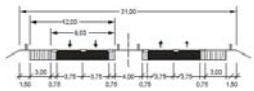
RQ 43,5



RQ 36



RQ 31

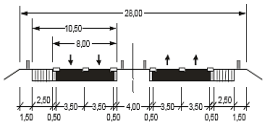


EKA 1
Source:German RAA

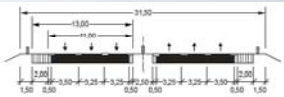
Bild 4.3: Regelquerschnitte für Autobahnen der EKA 1 (Abmessungen in [m])

Motorway - Regular Cross sections

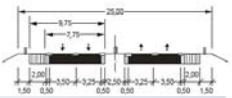
RQ 28



RQ 31,5



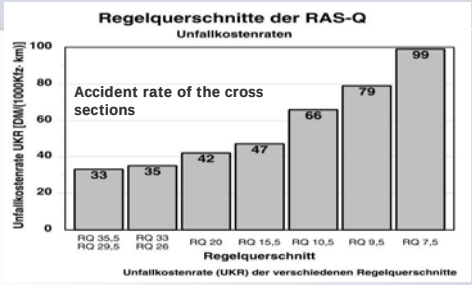
RQ 25



EKA 2 and 3
Source:German RAA

Comparison: safety properties

accident rate indicators of different cross sections



Research results from Germany, source: GDV

Crossfall, superelevation and drainage

Principle solution in Germany guideline source: RAS - Q

Typical cross fall:

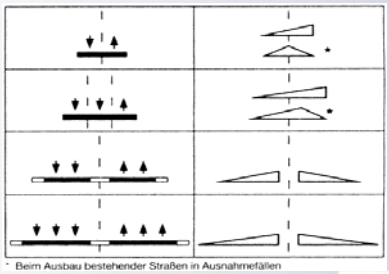
Germany (RAS – Q)

usually 2,5 %

USA (AASTHO. exh.4-4)

High surface 1,5 – 2 %

The higher crossfall is an advantage for the safety!



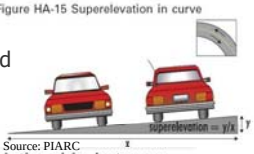
* Beim Ausbau bestehender Straßen in Ausnahmefällen

Superelevation

Superelevation:

Road's transverse incline toward the inside of a horizontal curve

Figure HA-15 Superelevation in curve



Source: PIARC

Table HA-4 Example – Relationship between superelevation and speed

SUPERELEVATION (m/m)	SPEED (km/h)
0.00	62
0.02	67
0.04	71
0.06	76
0.08	80

Radius = 250 m, coefficient of friction = 0.12

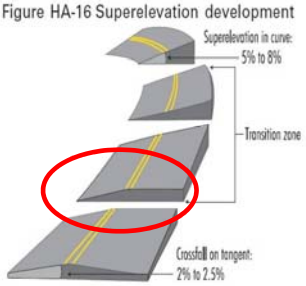
Source: PIARC

Superelevation and drainage

Example for the design transition cross fall - superelevation

New tendency in the future revision of German guideline: higher superelevation max. 7 %

Figure HA-16 Superelevation development



Source: PIARC

Superelevation and drainage

Design tool to choose the superelevation for motorways

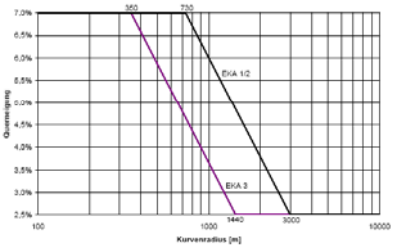
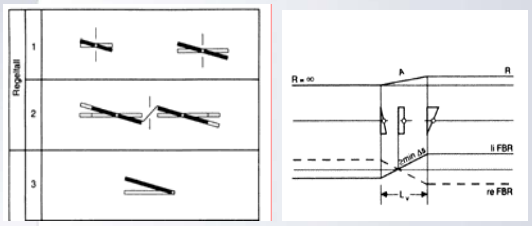


Bild 5.11: Querneigungen in Abhängigkeit von der Entwurfsklasse und den Kurvenradien

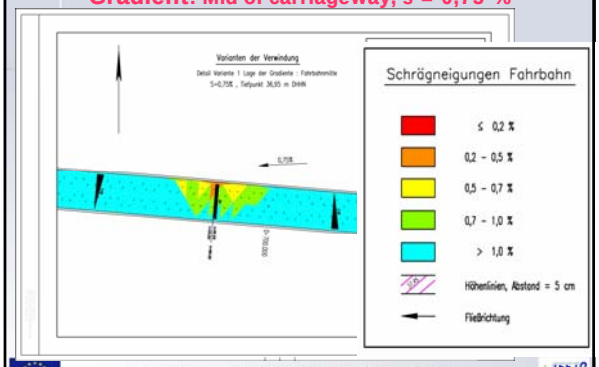
Source:German RAA

Superelevation and drainage



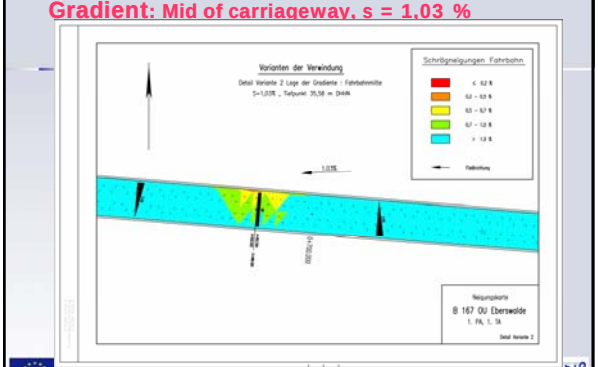
Digital model of diagonal fall

Gradient: Mid of carriageway, s = 0,75 %



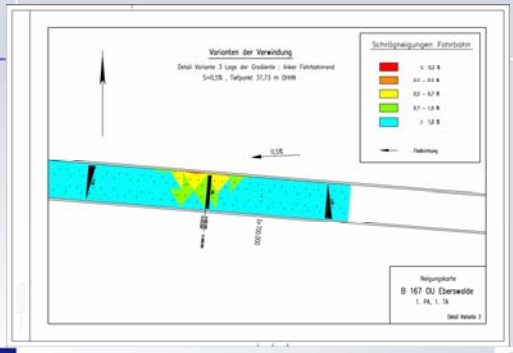
Digital model of diagonal fall

Gradient: Mid of carriageway, s = 1,03 %



Digital model of diagonal fall

Gradient: left edge of carriageway, s = 0,5 %



Cross section – slopes, problem erosion and falling material

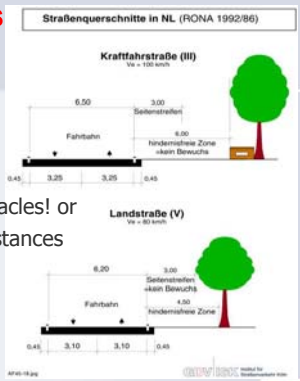
Erosion and falling material could be dangerous...

Pict: Montenegro

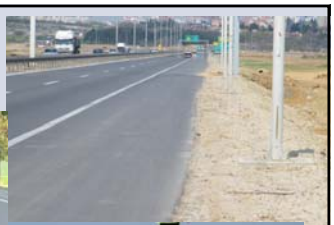
Pict. Example for a safety steel mash from Poland

Fixed obstacles

Target Avoid fixed obstacles! or
Set up at sufficient distances
or safeguarded !



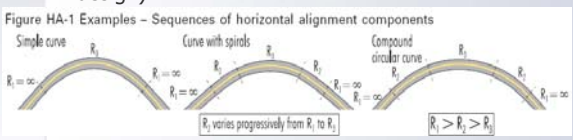
Fixed obstacles



4. Alignment

Alignment - General remarks

- Horizontal alignment: comprises of straight lines, circular curves and spiral curves
- In modern design of interurban roads the use of spiral curves is the normal case (so called dynamic design)



Source: PIARC

Is the horizontal and vertical alignment coordinated?

Are horizontal and vertical alignment coordinated?

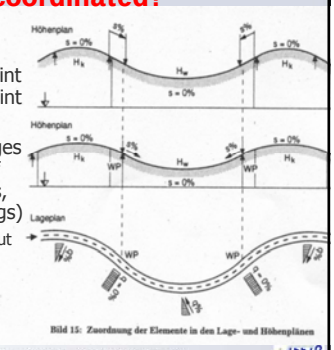
Ideal case => horizontal turning point and vertical turning point in the same position

Is the horizontal and vertical alignment coordinated?

- Horizontal turning point and vertical turning point in the same position
- Visibility of the changes of bends (beginning of curves not behind tops, not covered by buildings)

„Höhenplan" = vertical layout

„Lageplan" = horizontal layout



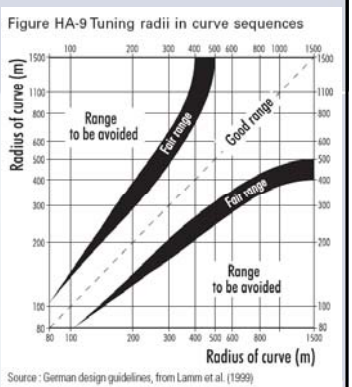
Continuity principles in road design

Please check:

- Relation alignment
- Minimum radii in the sequence of straigt– Klothoide – circle
- Avoid intermediate straights between the curves
- Avoid minimum radii
- Make clear sharp curves, short Klotoide ($A \geq R/3 \leq R$), no „basket" klotoide
- $R1/R2 \leq 1.5$ for radii R1 smaller than 1300 m!

Continuity principles in road design...

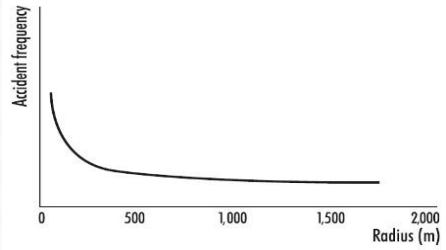
Rigth: radii in curve sequences



Source:PIARC

Continuity principles in road design

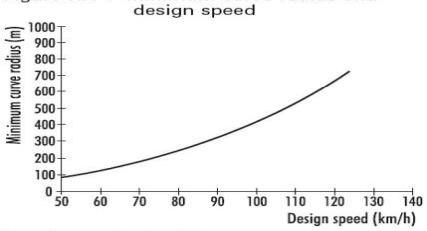
Figure HA-5 Accident frequency and curve radius



Source: PIARC

Continuity principles in road design

Figure HA-4 Minimum curve radius and design speed

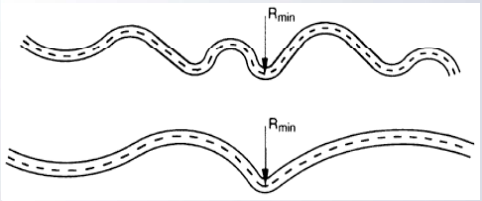


Source: PIARC

Source: Krammes et Garnham, 1995

Continuity principles in road design

Examples consistent and inconsistent design



Source: Geman RAS-L

Continuity principles in road design

curve minimum in case of radii straight - clothoide – curve

length L [m] of the Straigt	min R [m] of the curve
L ≥ 300 m	min R > 400 m
L < 300 m	min R > L

Source: RAS-L

Source: Geman RAS-L

Focus on safety: Possibilities to overtake safely (overtaking sight distances / overtaking lanes)

- Overtaking sight on 15 % und 40 % of the road section
- Otherwise additional lanes for overtaking
- Enough long straights (especially in dips)
- New tendency in Germany: separate passing lane in case of high traffic volume (or road section with 2+1 cross section)

Focus on safety: possibilities to overtake safely (overtaking sight distances / overtaking lanes)

Table HA-11 Minimum percentage of alignment with passing sight distance

COUNTRY	MINIMUM PERCENTAGE
SWITZERLAND, GERMANY	20%
FRANCE	25%
GREAT BRITAIN	15 - 40% (depending on the road category)

Source: PIARC

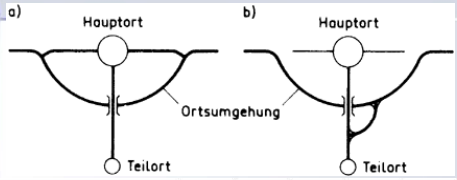
Transition interurban/urban sections

- Well designed measures

5. Intersections

Is a junction necessary ???

...and minimum distances between junctions



V_k [km/h]	50	60	70	80	90	100
Knotenpunkt-abstand [m]	140	170	205	235	270	300

Focus on safety: Is the planned number of junctions nessecary?

The risk of accidents on intersections is much Higher than at road sections!

Target for planning of interurban roads:

- Try to reduce the numbers of junctions
- high distance between junctions on arterial roads

General design principles for junctions

- **perceptibility**
- **clarity**
- **understandable**
- **drivible and walkable**

... that means the designer should try to design the intersection as small as possible...

General types of junctions

- **Roundabouts**
- **3 or 4 leg intersections**
- **Intersection with grade separation on Motorways (interchanges)**

Try to use the same type and shape in a road section and network, advantage for the safety (better re-detectability for the driver)

Choice of the intersection type according to capacity

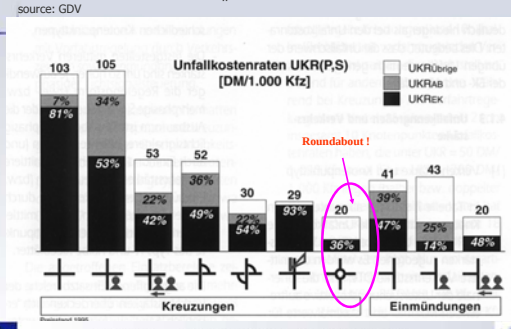
Table 1-1 Capacity based on intersection type

INTERSECTION TYPE	CAPACITY veh/d
Right-hand priority	1,000 – 1,500
Fixed-priority	5,000 –12,000
Single-lane roundabout	20,000 – 28,000
Multi-lane roundabout	35,000 – ?[a]
Signalized intersection	20,000 – 80,000[b]

[a] Variable between countries.
[b] Depending on the lane assignment.

Focus on safety: type of intersection and safety

Safe junctions – comparison of junction-geometries on interurban roads
German statistics about the „accident – cost – rates"
source: GDV



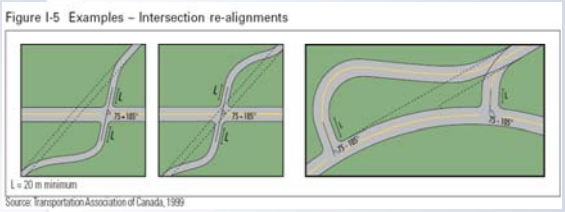
Safe type and design of junction?

some principles for a safe design:

- Coordination between alignment of the road and the type of the junction
- Approach roads: the angle between the main and the approach road should be between 80 and 120 gon (the best is 100 gon)
- The main road should be planned with the best design

Intersection T - Type

Proposals for safe solutions from Canada for re-alignment the Y into the T - type

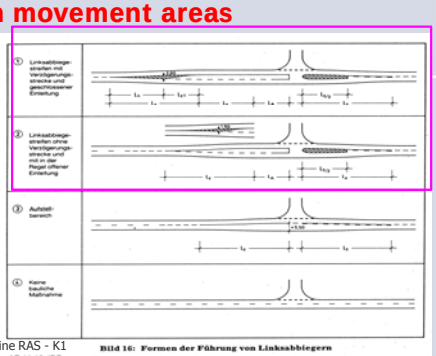


Example PIARC

Transformation from a Y intersection to a T intersection.

Focus on safety: Left-turn movement areas

For the safety are left turning lanes are recommended!

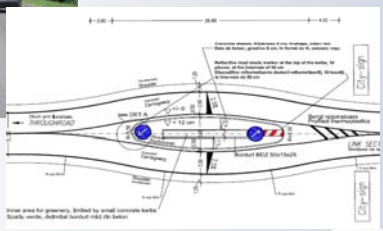


Source:German guideline RAS - K1

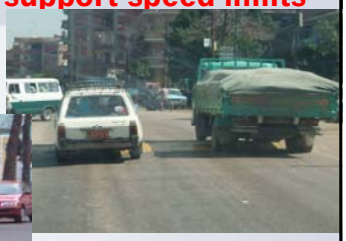
Bild 16: Formen der Führung von Linksabbiegern

6. Additional Measures

Measures to support speed limits



Measures to support speed limits



Measures to support speed limits

Signing and Marking

Thank you for your attention!

Any Questions?