

Safer design of interurban roads and motorways

by
L. Pfeiffer
Road Safety Audit Expert

Consortium:
WYG Engineering as Leading Partner
TRADEMCO S.A.
VIENNA CONSULT
TRL Ltd

Overview about content

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

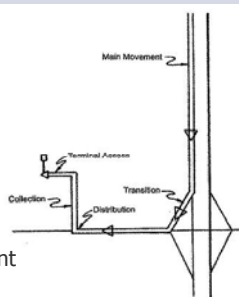
1. Road Function

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- 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?



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?

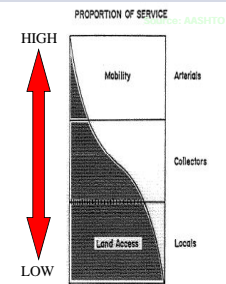
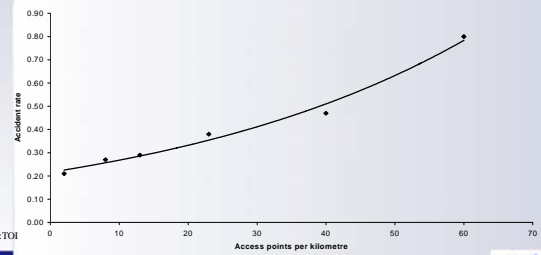


Exhibit 1-5. Relationship of Functionally Classified Systems in Serving Traffic Mobility and Land Access

Focus on road safety:

The Influence of the number access points to traffic accidents

Effect of access point density on injury accident rate



source: TOI

3. Cross section

3. Cross section

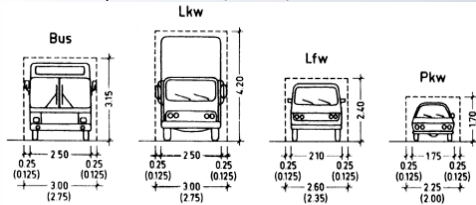
- Is the cross section design suitable for the traffic volume and traffic composition?
- Contradiction long distance transport – mixed traffic
- Cross section different types, decision on the basis of the traffic volume, composition and function...



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



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Interurban Highway - Regular Cross sections

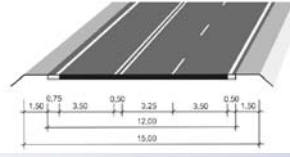
experience from Germany

One carriageway cross section

- special cross section with Overtaking lanes

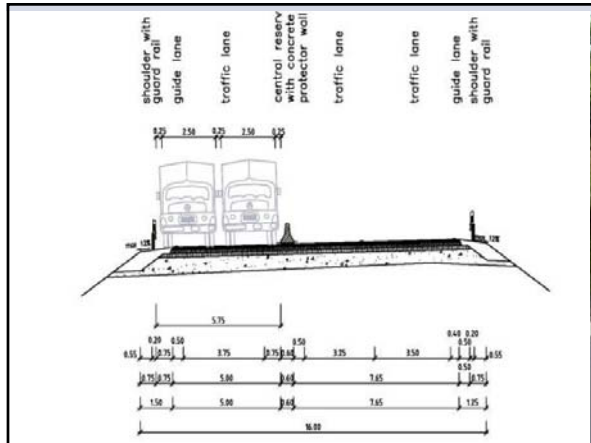


Regelquerschnitt für Straßen der EKL 2



source: Draft RA

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Interurban Highway - Regular Cross sections

experience from Germany

Regelquerschnitt für Straßen der EKL 3

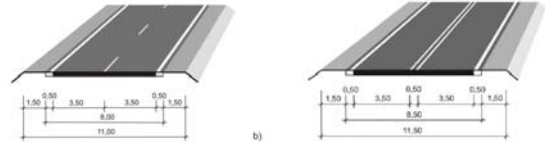


Bild 4.3-3 Regelquerschnitt RQ 11

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Interurban Highway - Regular Cross sections

experience from Germany

Two carriageway cross section for interurban roads and for expressways
Regelquerschnitt für Straßen der EKL 1 – EKL 3 mit sehr hohen Verkehrsbelastungen

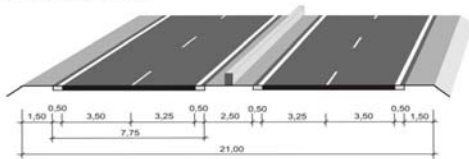


Bild 4.3-5: Regelquerschnitt RQ 21

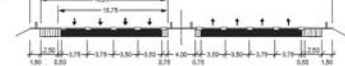
source: Draft RAL

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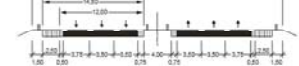


Motorway - Regular Cross sections

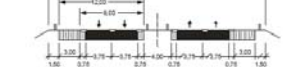
RQ 43,5



RQ 36



RQ 31

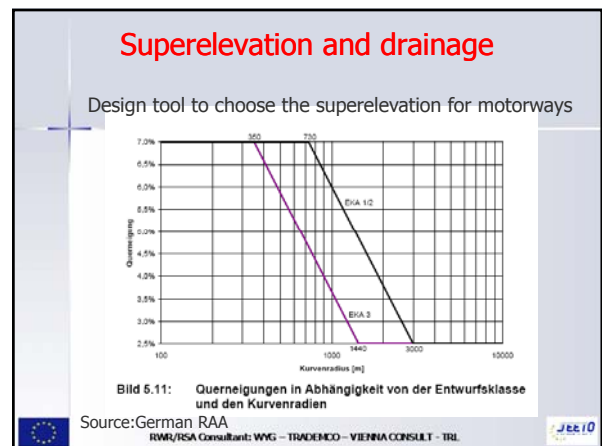
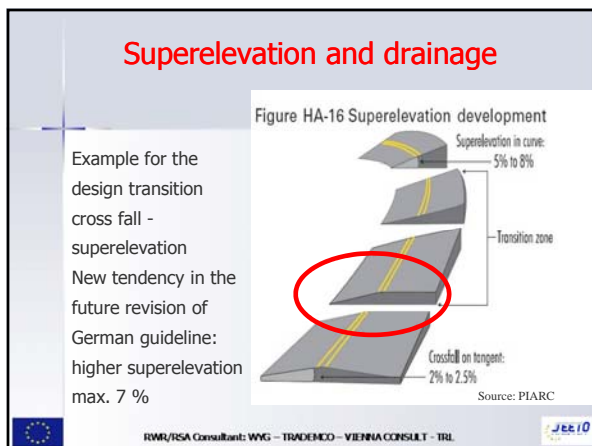
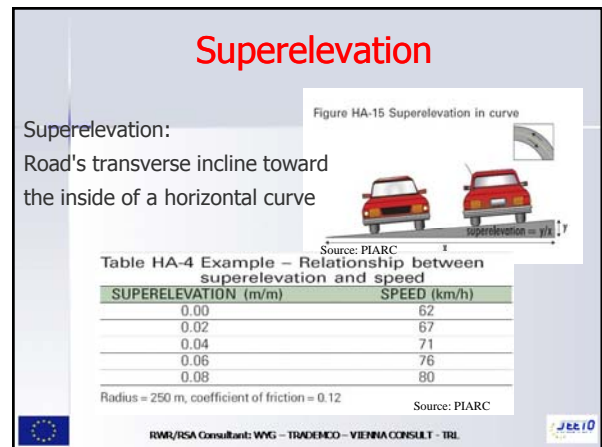
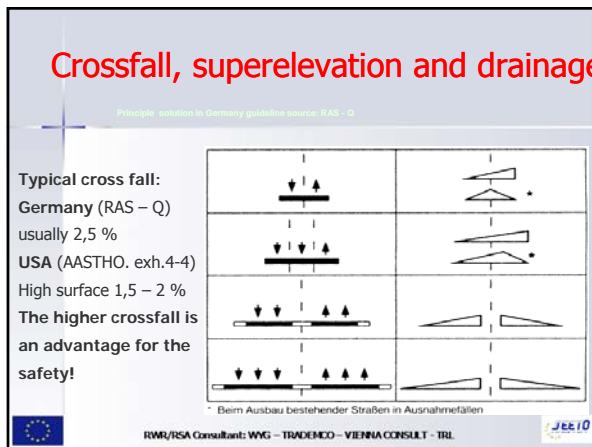
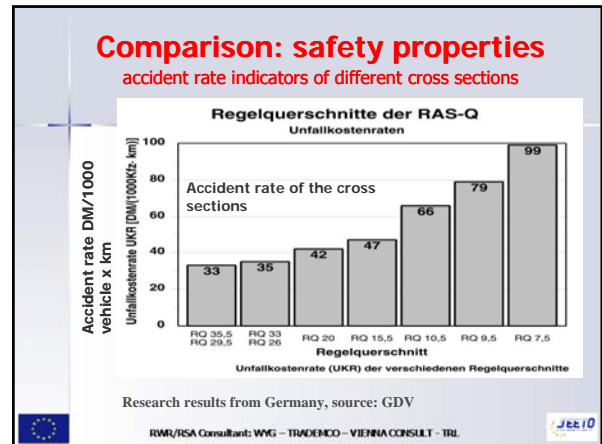
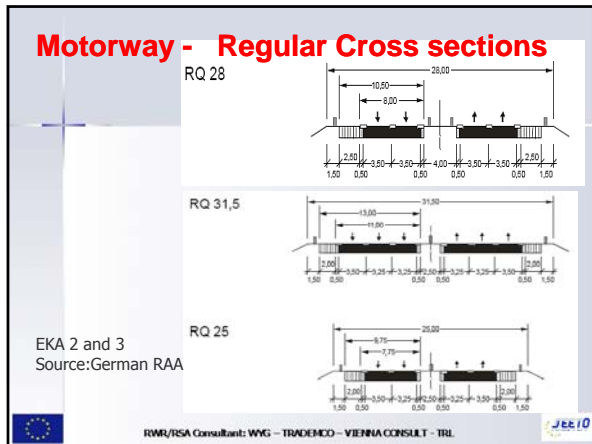


EKA 1
Source: German RAA

Bild 4.3: Regelquerschnitte für Autobahnen der EKA 1 (Abmessungen in fm)

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Superelevation and drainage

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Digital model of diagonal fall

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

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Digital model of diagonal fall

Gradient: Mid of carriageway, $s = 1.03 \%$

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Digital model of diagonal fall

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

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Cross section – slopes, problem erosion and falling material

Erosion and falling material could be dangerous...

Pict: Montenegro Pict. Example for a safety steel mesh from Poland

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Fixed obstacles

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

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Fixed obstacles



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JEE 10

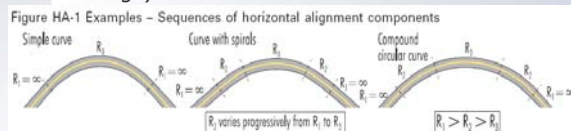
4. Alignment

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JEE 10

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

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JEE 10

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

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JEE 10

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

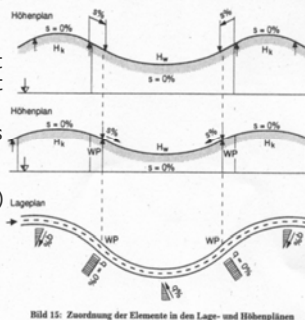


Bild 11: Zuordnung der Elemente in den Lage- und Höhenplänen

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Continuity principles in road design

Please check:

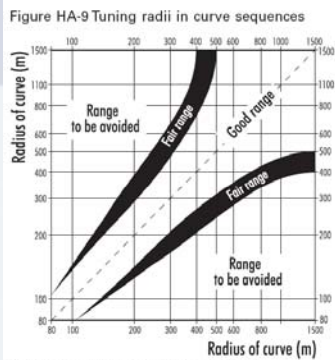
- Relation alignment
- Minimum radii in the sequence of straight-Klothoide - circle
- Avoid intermediate straights between the curves
- Avoid minimum radii
- Make clear sharp curves, short Klothoide ($A \geq R/3 \leq R$), no „basket“ klothoide
- $R1/R2 \leq 1.5$ for radii $R1$ smaller than 1300 m!

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JEE 10

Continuity principles in road design...

Right: radii in curve sequences



Source: German design guidelines, from Lamm et al. (1999)

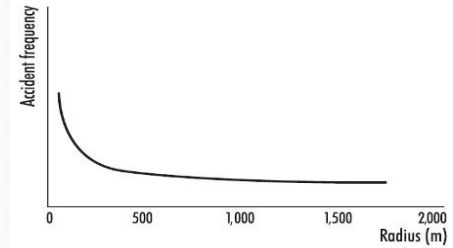
Source: PIARC

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Continuity principles in road design

Figure HA-5 Accident frequency and curve radius



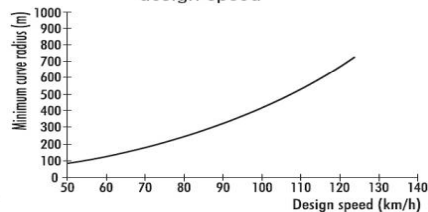
Source: PIARC

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Continuity principles in road design

Figure HA-4 Minimum curve radius and design speed



Source: PIARC

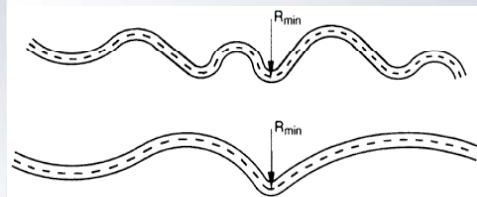
Source: Krammes et Garnham, 1995

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Continuity principles in road design

Examples consistent and inconsistent design



Source: Geman RAS-L

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Continuity principles in road design

curve minimum in case of radii straight - clothoid - curve

length L [m] of the Straigt	min R [m] of the curve
$L \geq 300$ m	min R > 400 m
$L < 300$ m	min R > L

Source: RAS-L

Source: Geman RAS-L

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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)

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**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

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**Transition
interurban/urban
sections**

- Well designed measures



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5. Intersections

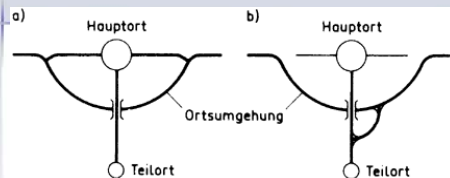
Please see separate presentation!

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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

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**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

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**General design principles
for junctions**

- perceptibility
- clarity
- understandable
- drivable and walkable

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

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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

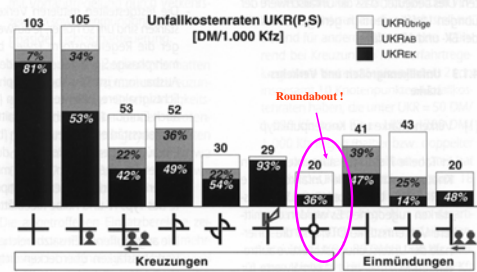
INTERSECTION TYPE	CAPACITY	veh/d
Right-hand priority	1,000 – 1,500	
Fixed-priority	5,000 – 12,000	
Single-lane roundabout	20,000 – 28,000	
Multi-lane roundabout	35,000 – 7*	
Signalized intersection	20,000 – 80,000 [†]	

* Variable between countries.

† 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?

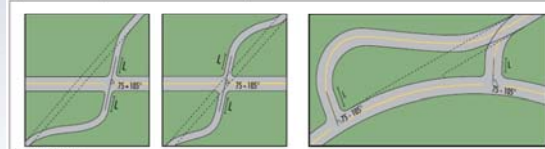
some principles for a safe design:

- 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

Figure I-5 Examples - Intersection re-alignments



L = 20 m minimum

Source: Transportation Association of Canada, 1999

Example
PIARC



Transformation from a Y intersection to a T intersection.

Thank you for your attention!
Any Questions?



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