Statens vegvesen

Rural design meeting Oslo, 2011

Randi Eggen

Norwegian Public Road Administration (NPRA)

Traffic Safety, Environment and Technology Department
Section: Transport Planning

Participants

- Germany: Kerstin Lemke
- Netherlands: Max van Kelegom, John Boender
  Sweden: Torgny Bäckström, Torsten Bergh
- Denmark: Anders Møller Gaardbo, Lene Herrstedt, Kenneth Kemstrup
- Finland: Pauli Velhonoja
- Norway: Tor Smeby, Olav Landsverk, Randi Eggen

Agenda 29. mars

1000 - 1030:	Welcome and breakfast
1030 – 1130:	Each country presents topics for discussion and gives an orientation about relevant new research. Each country can spend up to one hour. We start with the Dutch delegation
1130 – 1200:	Break
1200 – 1300:	Swedish topics presented by the Swedish delegation
1300 – 1400:	Lunch
1400 – 1500:	German topics presented by the German delegation
1500 – 1515:	Break
1515 – 1615:	Danish topics presented by the Danish delegation
18:00	Dinner

Dinner tonight

Agenda 30. mars

- 0830 – 0930: Finnish topics presented by the Finnish delegation
- 0930 – 0945: Break
- 0945 - 1045: Norwegian topics presented by the Norwegian delegation
- 1045 -1100: Break
- 1100 - 1130: Turbo roundabouts by John Boender
- 1130 - 1230: Lunch
- 1230 – 1330: Sight distances not only due to modern brake technology, but also regarding the height of crash barriers and rails, height of objects in the road, and if other countries like Norway have reduced sight distances in tunnels and reasons for that
- 1330 – 1430: Any other topics? Next meeting?

Topics for discussion (1)

1. The issue on the relation between lane width and construction/maintenance costs.
2. What is the policy on centre line markings in the different countries and how do these policies/requirements coincide with geometric design guidelines ? In Sweden: a one line system under 7 m and a two line system over 7 m with single broken lines at sight distances over X (don't remember the value at writing) m. And at lower sight distances, a single warning line, if under 7 m, and a double solid or combined solid-broken if over 7 m. And the solid line is only visualizing the underlying traffic code claiming overtaking to be forbidden at sight restrictions. Other solid lines require an administrative decision and solid lines as well as a traffic sign.
3. What speed limits are used for the alternative cross-sections ? For passenger cars, vans, trucks and buses ?
4. We have rather tough requirements on inner and outer slopes (1:4 and 1:6 without barriers) and clear zones. The German and Danish recommendations are different ... We consider barriers to be superior to clear zones ... Opinions from other countries ?
5. We're also interested in the use of one lane sections but find the German recommendation to use this up to AADT 3000 to be questionable in Sweden and at what lengths ? Experience and any legal implications ?

Topics for discussion (2)

6. We understand the German recommendations to be a one-sided 2.5 % crossfall on tangents, 2.5 % in curves 1000-3000 m and up to 7 % under 1000 m and “negative” over 3000 m at a speed limit of 100. Any new research supporting negative cross fall over 3000 m ? Other countries ? Motorways ?
7. Sight distances – modern braking technology ... shorter sight distances in guidelines ?
8. The EU directive on traffic safety – any impact on guideline production ? Safety audit on the guideline ? Project audits with the guideline as the recommendation ?
9. Motor cycles – any impact on your guidelines/recommendations
10. Review of guidelines to decrease investment and life cycle costs ?

Norwegian guidelines for street and road design

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”The norwegian hour”

- Challenges in Norway
- New research and development in connection with the new guidelines
- Improving standard for existing roads
- Questions /topics for discussion

New Norwegian guidelines for road and street design

- The last guideline was published in 2008
- www.vegvesen.no/fag/publikasjoner/håndbøker/håndbok 017 Veg- og gateutforming
- A new guideline is ready to publish this year

Road network and accidents

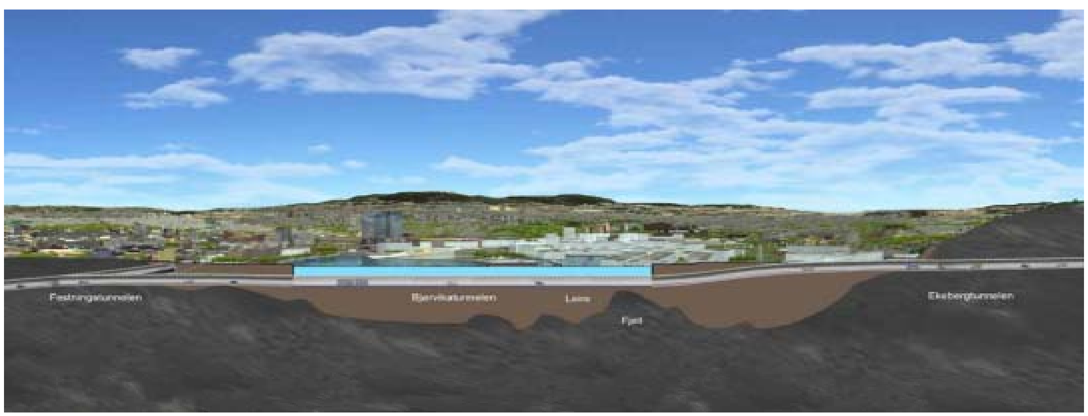
- From 01.01.2010 the county roads increased with more than 60 %, from 27 000 km to almost 44 000 km
  In addition comes 77 ferry connections.
- The national road network is now 10 500 km with 18 ferry connections. Previous the national roads were about 27 000 km
- Last year 210 persons were killed on Norwegian roads and 673 were severe injured (total 883 persons)

Road ownership as of 1 January 2010

Public roads, total:	93 214 km
National roads (state-owned):	10 500 km
County roads:	44 000 km
Municipal roads:	38 515 km

Immersed tunnel in Bjørvika

- The immersed tunnel lies on the gravel foundation without any other form of foundation being required. The tunnel elements have an unladen weight of 1.1 which means the load exerted on the fjord bottom is marginal.
- See www. Vegvesen.no



News in the proposal to new guidelines

- More detailed description of a standard for improving existing roads
- Considering more use of 2 lane roads with central barriers
- New method for calculating acceleration- and deceleration lanes
- New calculation of speed development for heavy vehicles in steep hills

New research and development (R&D) in connection with the new guidelines

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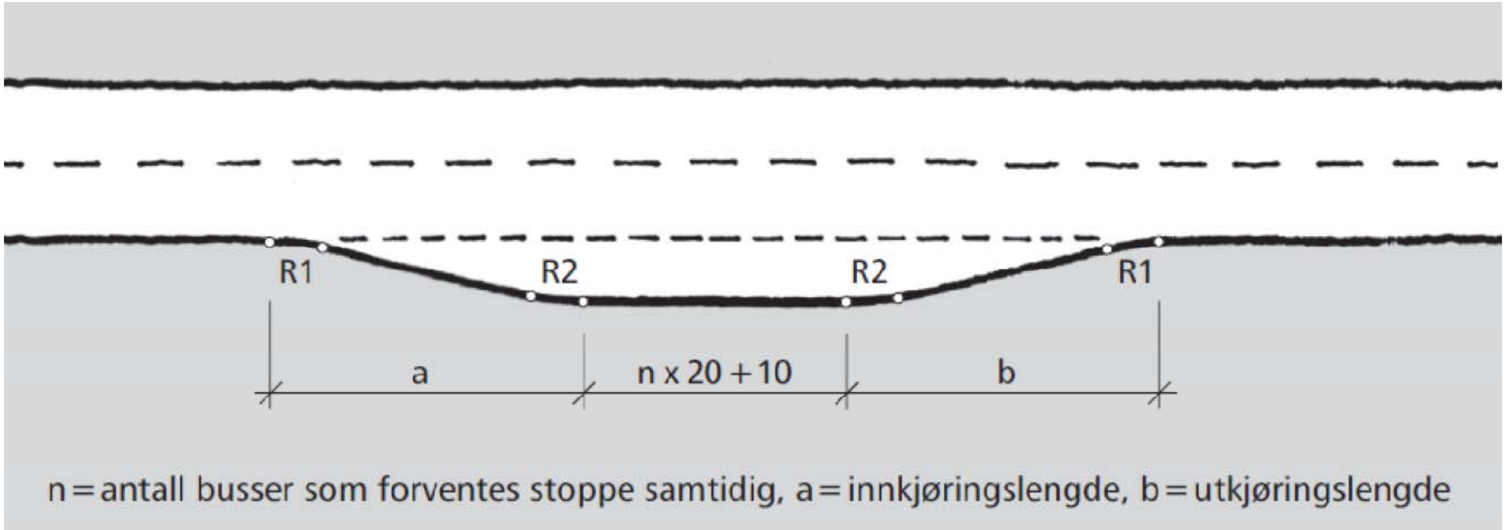
R & D

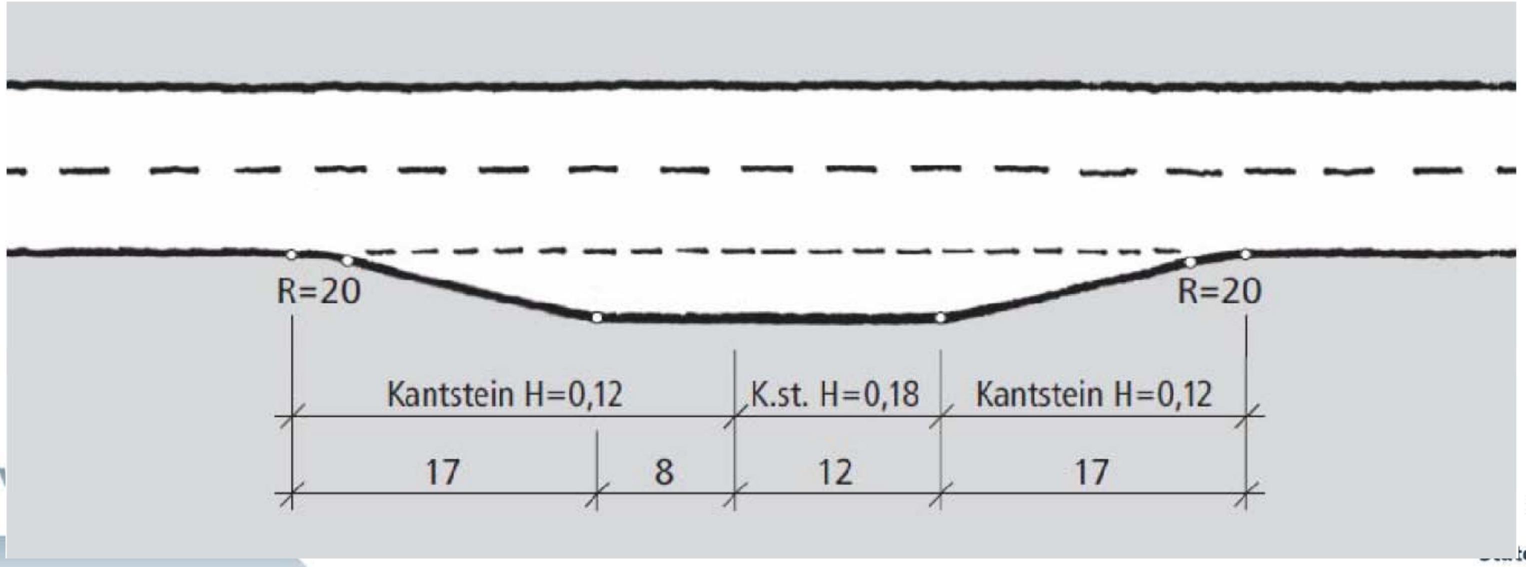
- Testing new bus-stops to use on existing roads which are universal designed (allow all user groups to use the solution)
- We are about to learn more about friction on roads (measuring friction, total friction, breaking friction, safety margins)
- New calculation methods for acceleration- and retardation lanes and overtaking lanes in steep hills for heavy vehicles

Bus-stop: Improvement standard

- **New roads (70 m)**



- **Improvement standard (54 m)**



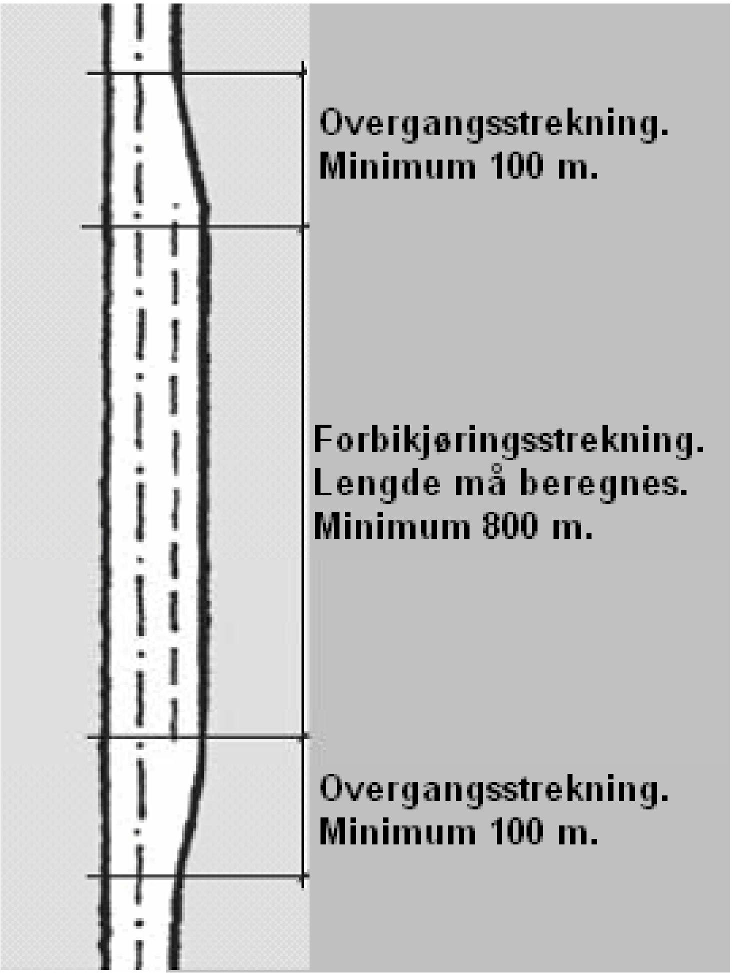
Lanes for overtaking

- Changes in red:

- **Overtaking lanes established in ascents when:**
  - ADT > 4 000.
  - The ascending gradient is steep and long enough to give to give big speed difference between heavy and light vehicles.
  - The designed speed difference is > 15 km/h.
  - Overtaking lanes ends where the speed differential between heavy and light vehicles reach 10 km / h.

- A differential speed 20 km/h is acceptable where the number of heavy vehicles per day is less than 400.

  A speed differential 20 km/h is acceptable where the speed limit is 90 km/h.



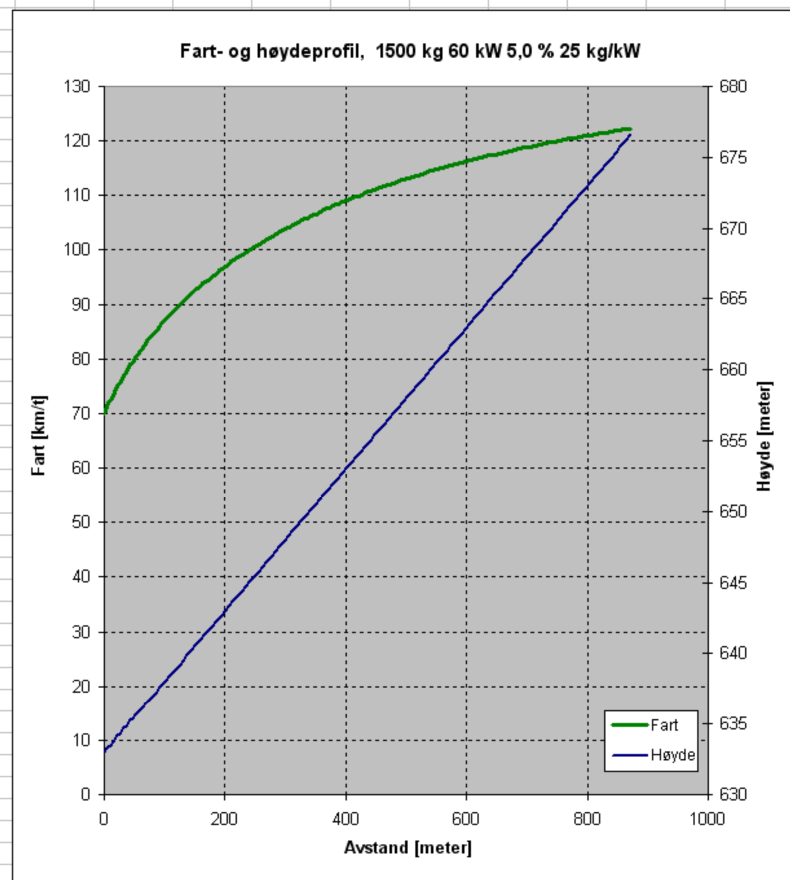
Overtaking lanes in steep hills

- Well-documented assumptions in the new spreadsheet
- Calculations are based on documented input data
- We are using a representative heavy vehicle to calculate the speed development (9kW/ton)

	A	B	C	D	E	F	G	H	I
1	**GRUNNLAGSDATA** (gule (og grønne) felt kan endres):								
2									
3	Kommentar:			Modell					
4									
5									
6	Tidsintervall		deltaT	0,25	sekund	Brukes for å formatere grafen			
7	Tyngdeakselerasjon		g	9,81	m/s^2				
8	Tetthet luft		rho	1,20	kg/m^3	Ved vanlig temperatur og trykk			
9	Vindhastighet		v0	0,0	m/s	(+ = motvind)			
10									
11	Rullemotstand		f	0,015		Typisk område 0.010 - 0.020			
12	Luftmotstand		cw	0,40		Personbil 0.30-0.50, lastebil 0.50 - 0.70			
13	Areal		A	2,0	m^2	Personbil ca 2 m^2, lastebil ca 8 m^2			
14									
15	Startavstand		x1	0,0	meter	For grafisk framstilling			
16	Starthøyde		h1	633,0	meter	For grafisk framstilling			
17	Starthastighet		v1	70	km/t				
18	Maxhastighet		v_max	150	km/t				
19	Max akselerasjon		a_max	3,4	m/s^2	**KLADD - ulike mål for effekt**			
20									
21	Masse		m	1500	kg	Dreiemoment		380	Nm
22	Maks effekt		P_max	60,0	kW	Turtall		2500	o/min
23	Tilsvarer i HK			81,6	HK	Effekt		99,5	kW
24	Masse / effekt forhold			25,0	kg/kW	Tilsvarer i HK		135,3	HK
25				18,4	kg/HK				
26	Effekt / masse forhold			40,00	W/kg	Effekt i HK		81,6	HK
27				54,40	HK/tonn	Tilsvarer i kW		60,0	kW
28									
29	Tidsforbruk		Lett	872	meter	70,0	km/t	44,9	sek
30			Tung	872	meter	104,7	km/t	30,0	sek
31								-14,9	sek
32									
33	Angi utnyttelse av effekten for hver delstrekning i tabellen under								
34									
35	Delstrekninger:							utnyttelse	utnyttet
36			stigning	lengde			høyde	grad	effekt
37			S	L	fra	til	H	u	P
38			prosent	meter	meter	meter	meter	prosent	Watt
39		1	5,0	10000	0	10000	500,0	100	60000
40		2	0,0	0	10000	10000	0,0	100	60000
41		3	0,0	0	10000	10000	0,0	100	60000
42		4	0,0	0	10000	10000	0,0	100	60000
43		5	0,0	0	10000	10000	0,0	100	60000

GRAFISK FRAMSTILLING (se også eget ark):

Versjon 2009-03-22 / AAa



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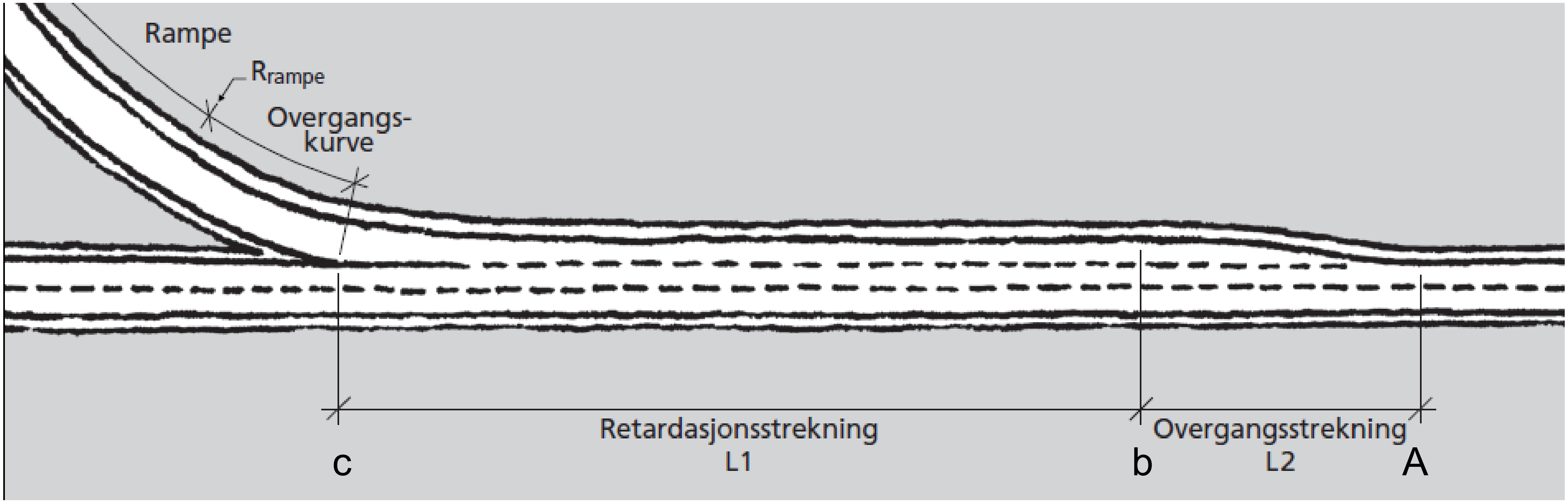
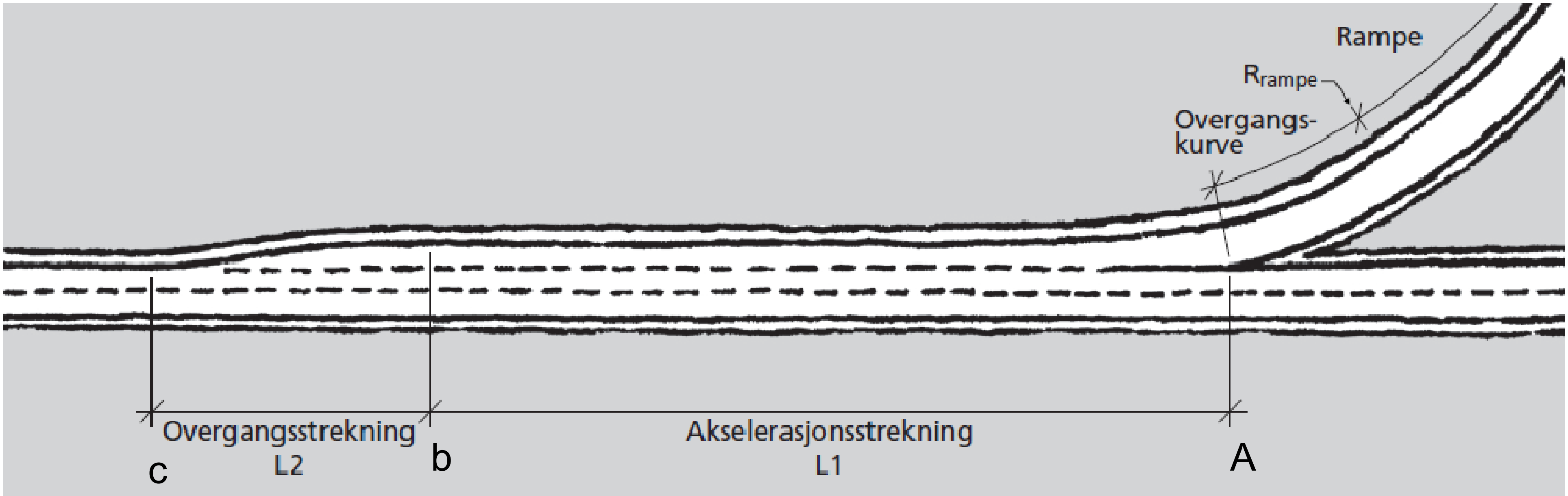
Deceleration lanes



- **The deceleration lane L1** (New defined definitions)
- L2 (the transition part) is unchanged
- **Defined transitions**
  - Point A: The widening begins
  - Point b: The widening ends, full lane width is reached. At this point the deceleration begins.
  - Point c: the point where both, vertical and horizontal curves, begin to differ from the carriageway.

Acceleration lane



The length of the acceleration lane L1

- L2 (the transition part) is unchanged
- Klart definerte punkter
  - Point A: The acceleration lane gets the same vertical and horizontal curve alignment as the primary road. It represent the start of the acceleration lane.
    Point b: The start of the transition part L2. At this point the acceleration is finished.
  - Point c: the endpoint of the transition section where the with is zero.

Acceleration lane

- Akselerasjonsfelt L1 lengde:
  - Calculated from a spreadsheet
    - Assume a light vehicle about 40 kW/ton
    - Assume 50 km/h when entering the acceleration lane in trumpet / cloverleaf junctions
    - Assume 70 km/h when entering the acceleration lane in diamond junctions
  - We differ on rise and fall. The length of the acceleration lane depend on the rise or fall of the primary road (length direction).

		Kløverblad-/trompetkryss				Ruterkryss			
	Fart:	**60**	**80**	**90**	**100**	**60**	**80**	**90**	**100**
STIGNING	-5	70	110	140	180	50	90	120	150
	-3	70	120	150	200	50	100	120	150
	0	80 (80)	150 (150)	180 (180)	230 (220)	50 (40)	110 (80)	130 (90)	180 (120)
	3	80	180	220	280	50	110	150	230
	5	90	210	250	330	50	120	180	270

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Standard
for improving existing roads

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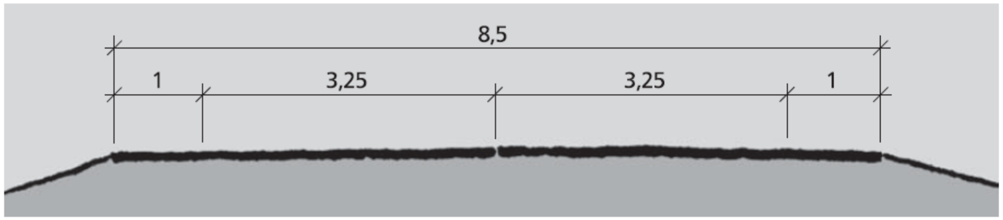
Advantages

Reduced geometric standard compared to new roads.

- Gives better adapting to the terrain
- Cheaper than the new road standard
- In many cases: more realistic to accomplish

Design-example (road class H3)

- Cross-section



Figur C.2: Tverrprofil S1, 8,5 m vegbredde og ÅDT 4 000 – 12 000 (mål i m)

- Horisontal - and vertikal alignment

Min.transition curve param.

Minimum stop-sight

Minimum Summit-curve in cross-sections

Maximum crossfall

Max. slope

Minimum horisintal curve

Minimum Summit-curve

Minimum Sag-curve

R[1]	Nabokurve Min	Nabokurve Maks	Klotoide Min	Siktlengde[2] Stopp	Δst1	Δst2	Forbi	$R_{v,høy}$ Min	$R_{v,høy}$ i kryss	$R_{v,lav}$ Min	Overhøyde e	Stigning Maks	Res. fall Maks	Res. fall Min
450	450		180	175	-18	27	550	6400	[illegible]	2600	8,0	6,0	10,0	2
500	450		195	180	-19	28	550	6800	[illegible]	2600	8,0	6,0	10,0	2
550	450		205	180	-19	28	550	6800	[illegible]	2700	8,0	6,0	10,0	2
600	450		215	185	-20	28	[illegible]	7100	-	2700	8,0	6,0	10,0	2
700	450		230	190	-20	29	[illegible]	7500	16400	2800	8,0	6,0	10,0	2
800	[illegible]		240	195	-23	36	[illegible]	7900	17300	2900	7,5	6,6	10,0	2
900	[illegible]		250	195	-23	36	[illegible]	7900	17300	2900	7,0	7,1	[illegible]	2
1000	[illegible]		255	200	[illegible]	[illegible]	[illegible]	[illegible]	18200	3000	6,5	7,6	[illegible]	2
1200	[illegible]		[illegible]	200	[illegible]	[illegible]	[illegible]	[illegible]	18200	3000	[illegible]	[illegible]	[illegible]	2
1400	[illegible]		[illegible]	205	[illegible]	[illegible]	[illegible]	[illegible]	19100	3100	[illegible]	[illegible]	[illegible]	2
1600	[illegible]		[illegible]	205	[illegible]	[illegible]	[illegible]	[illegible]	19100	3100	[illegible]	[illegible]	[illegible]	2
≥ 1750	[illegible]		[illegible]	205	[illegible]	[illegible]	[illegible]	[illegible]	19100	3100	[illegible]	[illegible]	[illegible]	2

(Horisontalkurvaturparametre: R through Forbi; Vertikalkurvaturparametre: $R_{v,høy}$ through Res. fall)

Neighbour curves

Minimum overtaking distance

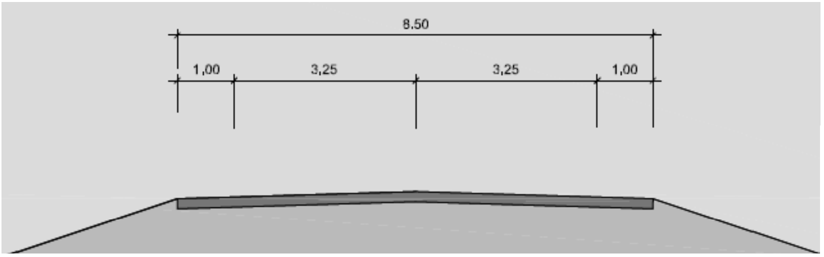
Resultant crossfall

- Overtaking
- Recommended Junction types
- Private entrance, access conditions...
- Solutions for pedestrians and cyclists
- Public transport infrastructure
- Lighting
- Service facilities
- Standard vehicle and tracking
- Free height

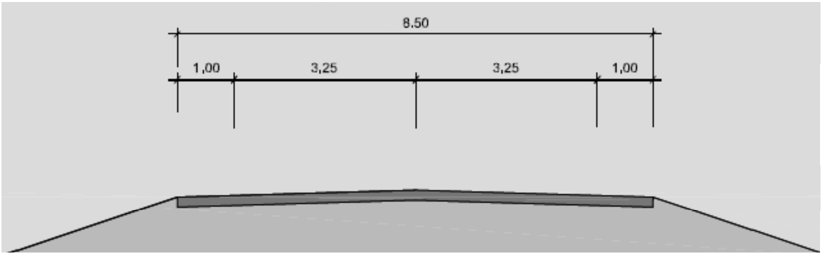
Reduction of the basic parameters by choosing the ”improvement road standard” for the road class H2

Road class / Parameters	H2	U-H2			
Annual Daily Traffic (ADT)	0 – 4 000	0 – 1 500	1 500 – 4 000	0 – 1 500	1 500 – 4 000
Speed limit	80	60	60	80	80
Speed addition	5	0	0	0	0
Speed geometri (alignment) addition	10	0	0	0	0
Safety friction factor (added)	1,25	1,1	1,25	1,1	1,25
Resultant crossfall	10	11,3	10	11,3	10
Vertikal accelleration	0,3	0,5	0,5	0,5	0,5
Calculated object height, a_2	0,25	0,25	0,25	0,6	0,25
Maximum slope	8 %	8 %	8 %	8 %	8 %

H2



U-H2 (no change)



Some of the aligment construction demands using improvement standard U-H2 for H2:

Caused by the change in the basic parameters the minimum alignment demands will be like this (when using improvement standard U-H2 instead of using road class H2):

Road class / Parameters	H2	U-H2 ÅDT 0-1500 60 km/h	U-H2 ÅDT 1500-4000 60 km/h	U-H2 ÅDT 0-1500 80 km/h	U-H2 ÅDT 1500-4000 80 km/h
Annual daily traffic (ADT)	0 – 4 000	0 – 1 500	1 500 – 4 000	0 – 1 500	1 500 – 4 000
Speed limit	80	60	60	80	80
Minimum horisontal curve	250	100	100	200	225
Minimum transition curve (chlotoid) parameter	125	65	65	110	115
Minimum stopsight	115	60	65	100	105
Minimum summit curve	2800	700	800	1400	2300
Minimum Sag-curve	1900	600	600	1000	1000

Effects

- Now we are working on calculating the consequences of implementing the reduced standard in Norway
- We hope the road will be cheaper to build and be almost as safe as a new built road
- The planning process will decide if we should build a new road or improve the existing road up to this defined standard

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Discussion

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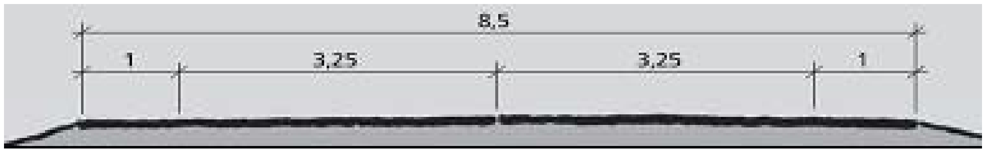
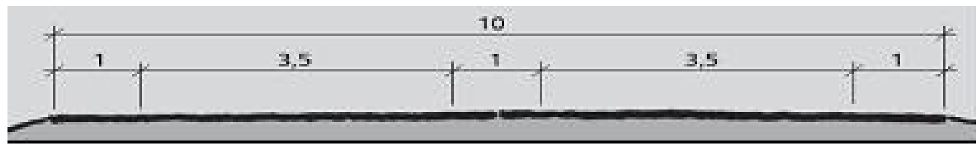
Dagens krav - nasjonale hovedveger
(V = 80-100 km/t)

ÅDT 0-4000



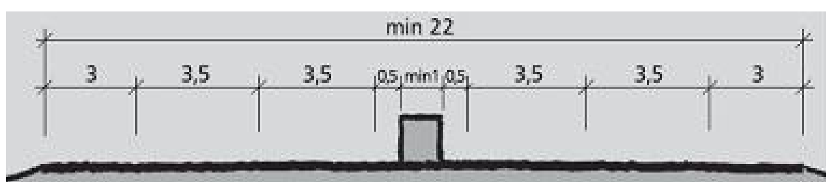
ÅDT 4-8000



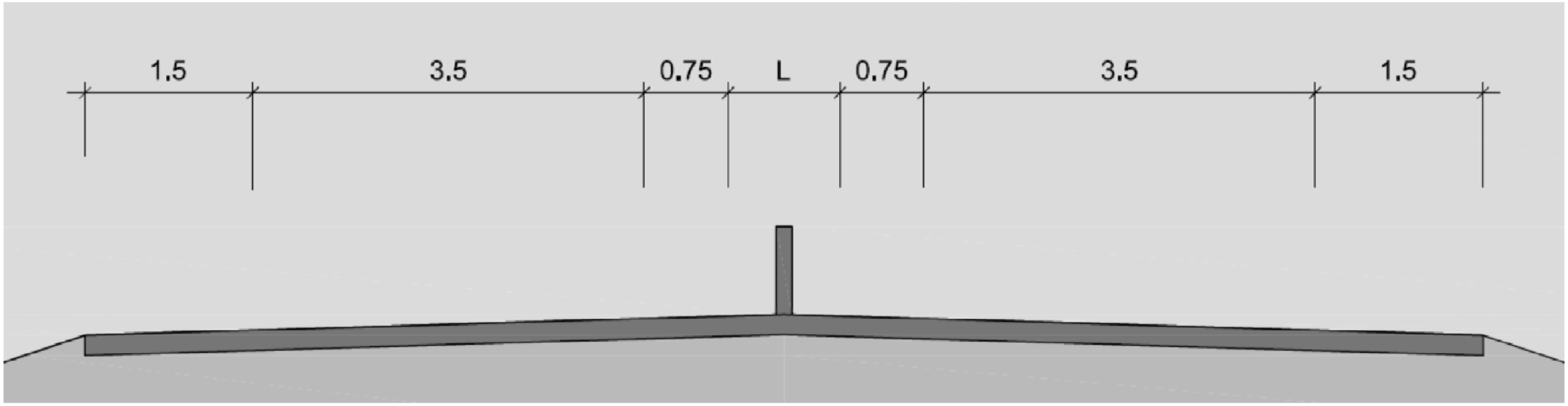
ÅDT 8-12000

ÅDT > 12000

ÅDT > 20000



Median guardrail

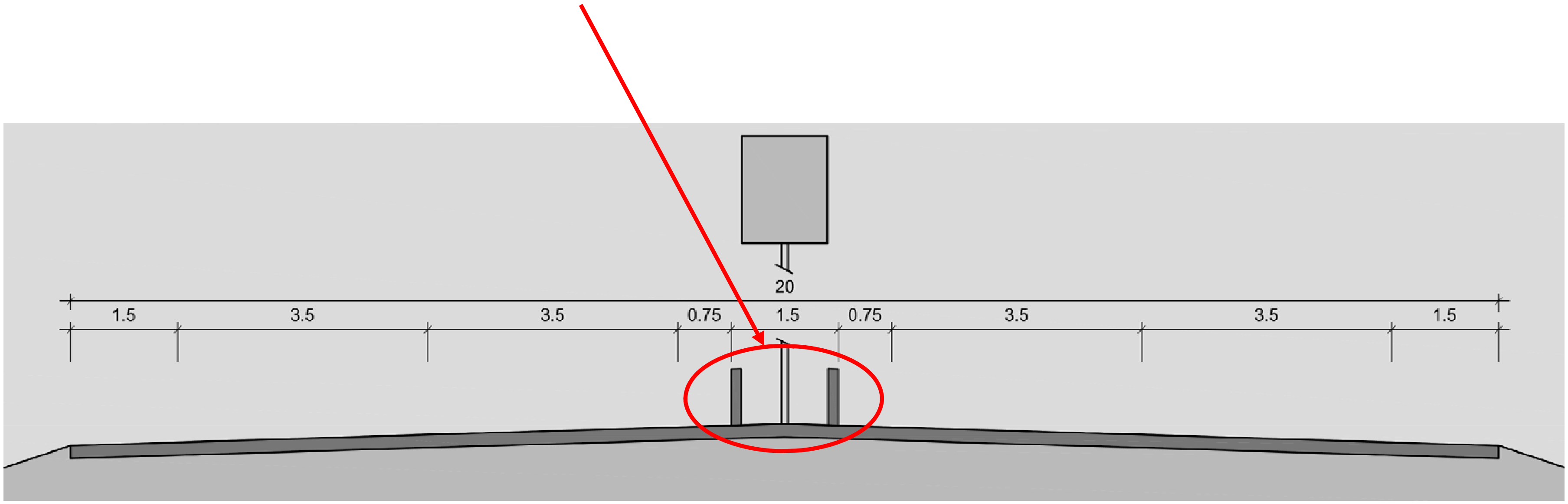


For roads with 2 or 3 lanes it is recomended that signs are placed on the road's left side. The median width L will be determined from the width of the guardrail (Br) and the working width (W) of the guardrail.
The width L is calculated like this:

L = 2(W-1,5 m) – Br when W > 1,5 m
L = Br when W ≤1,5 m

Median

- Median used to separate two carriageways (design of multiple lane highways)



Topics for discussion

- How narrow can 2 lane roads with central barrier be?
- For which traffic volumes can these type of roads be used?
- How do you design intersections on 2 lane roads with central barrier?
- Which criteria for overtaking possibilities should these roads have?

Stopping spots (pockets) on highways

- On highways with sholulderwidth of 1,5 m we now suggest to establish stop spots every 3rd km.

Do any of you have requirements like that?