Roadside area design – Swedish and Scandinavian experience

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Abstract

This paper gives an overview of the development of Swedish guidelines and requirements for roadside areas in design and speed limit decisions from the first introduction of safety in the mid 70:ies to date. Major Swedish efforts to study traffic safety impacts are also summarized and commented. Important conclusions for Swedish practice are drawn.

The present SRA, Swedish Road Administration, opinion based on experience claim modern guard-rails to be a better traffic safety option than smooth roadside design in most conditions. The exceptions would be deep soil cuts and low fills with very large clear zones. The major con of guard-rails is maintenance costs.

A slope guard-rail has been developed with the purpose to enable guard-rail implementation in existing 1:3 fore slopes on two-lane roads. The concept is to install the barrier in the slope to avoid problems for pedestrians and bikers and also for snow removal using the traditional location at the edge of the carriageway.

The advantage of 1:6 fore slopes to 1:4 and even 1:3 is very much questioned. Full scale crashes and simulation studies claim 1:3 fill slopes to be competitive with the slope end design to be important. V-shaped ditches should be avoided at the bottom.

Scandinavian research based on full crash tests and simulation studies propose U-shaped cut designs with 1m 1:3 fore slope, 0.2 m ditch width and 1:1.5 or 1:2 back slopes to be superior to 1:4 and 1:6 designs. The explanation would be a bigger capacity to catch and control the vehicle within the cut.

Follow-up studies indicate a major traffic safety advantage with barriers also for motorcyclists. The VTI 2+1-roads study conclude on a 40 to 50 % decrease in severe and fatal injuries for motorcyclists.

Follow-up studies have been very difficult to conduct. The main reason is poor records on roadside area conditions in existing road registers and also in project documentation. The following important results could be summarized:

- A 20 % positive difference between motorways with modern roadside areas and without.
- A significant decrease in severity rate for single run off accidents with increasing traffic flow on two-lane roads. This is interpreted to be explained with differences in roadside areas, though not documented.

1. OBJECTIVES

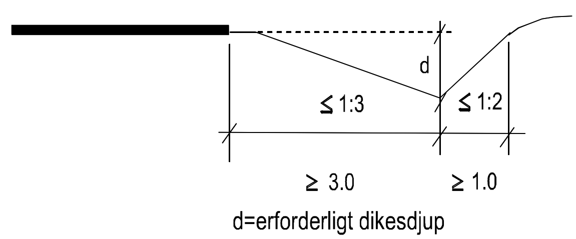
The objectives of this paper are to:

- give an overview of how guidelines on forgiving roadside design has developed in Sweden since the 1970:ies up to date
- present how roadside area conditions are treated in the present review of Swedish speed limits
- present an overview of important results and empirical findings from Swedish and some other Scandinavian studies on traffic safety performance due to roadside area conditions

2. FORGIVING ROADSIDE AREAS IN SWEDISH DESIGN GUIDELINES – AN OVERVIEW

The concept with traffic safety as an important factor in roadside area design was introduced in Sweden in the mid 70:ies inspired by mainly German and US research and guidelines at that time. The first humble Swedish step was to implement a 1:3 inner slope as a standard design to replace former practice (ref 7); only designing for the friction angle of the material used in the specific construction; often 1:1.5 or 1:2. Back slopes were still 1:2 in soil cuts and 1:1.5 in rock cut. Clear zone requirements were 4 m at 90 kph and 6 m at 110 kph on tangents. Motorway medians without barriers were recommended to be at least 8 m with 1:4 slopes. The standard V-shaped ditch depth was approximately 1 m to drain the pavement construction. A typical design of that time is shown in Figure 1.

Real life example roadside area design from the 1970:ies



Roadside area cut design from 1970:ies' guidelines

Figure1- Typical Swedish roadside area from the 1970:ies

Given fixed obstacles within the clear zone guard-rails, at that time a German W-beam design, were required. Terminations were designed to avoid run-off crashes down to an encroachment angle depending on design giving termination lengths up to some 55 m for 4 m offset at speed limit 90 kph and 85 m at 110 kph for 6 m offset.

The design guidelines VU 94 part 5 (ref 10) from 1994 was a breakthrough for modern roadside area designs with clear zone requirements of 9 m at 90 kph and 10 m at 110 kph on tangents. The US concept of smooth slopes was also implemented with three alternative designs depending on traffic volumes and speed limit, in Sweden normally 90 or 110 kph on major rural roads at that time, see Figure 2:

- 1:6 inner slopes; in cuts with a 0.5 m deep ditch with a culvert for drainage with 3 m inner and 3 m lower outer slopes followed by a 2 m 1:2-slope up to 1 m over the carriageway height. On fills, a 6 m 1:6 inner slope followed by a broken 1:3-slope.
  Recommended for 90 kph at traffic flows over AADT 4000 and for 110 kph at traffic flows over AADT 2500

- 1:4 inner slopes; in cuts with a 0.5 m deep ditch with or without culvert for drainage with 2 m inner and lower outer slopes followed by a 2 m 1:2-slope up to 1 m over the carriageway height; On fills, a 4.5 m 1:6 inner slope followed by a broken 1:3-slope.
  Recommended for 90 kph at traffic flows over AADT 2500 and for 110 kph at traffic flows over AADT 1000
- Traditional 1:3 inner slopes; in cuts with a 1 m deep ditch (depending on construction) with 1:3 inner slope and 1:2 outer slope.

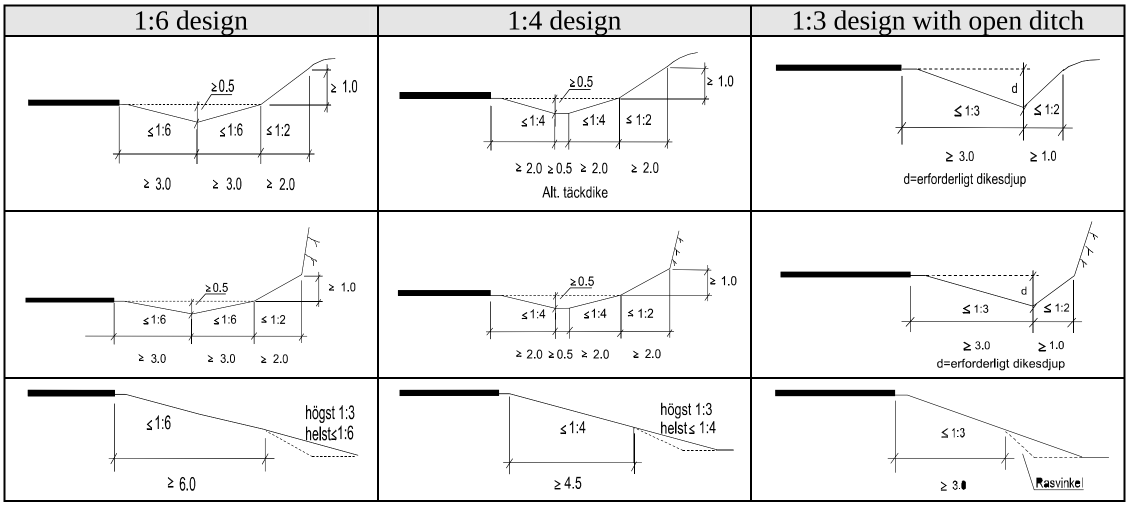


Figure 2 – VU94 roadside design alternatives

These guidelines were based on rather extensive research (ref 4, 5, 6). There was an intense discussion before the introduction on the pick between 1:4 and 1:6 designs questioning the advantages of the 1:6 alternative.

The VU 94 also introduced the, at that time, preliminary functional guard-rail recommendations (ref 10) applying capacity N2 according to European standard, EN1317, for speed limits over 70 kph given fixed obstacles inside the clear zone.

Experiences gained over time described in some more detail in the following chapters of this paper introduced some important changes in roadside area strategies in the revised roadside area design guidelines (ref 14) and the present design guidelines VGU (ref 15). The clear zone requirements are still valid. The main changes could be formulated:

- A guard-rail is in most cases judged to be superior to a smooth roadside area design. The only exceptions would be an infinite clear zone at a low embankment and a nicely designed soil cut. The main reasons are a number of severe accidents not avoided by the design. Encroaching vehicles, especially related to drowsiness, has traversed the roadside are and crashed with a fixed object further out or being tracked driven long 100:s of m crashing abutments at underpasses. Quite often, the driver has got aware what is happening, panicked and the vehicle has come out on the road again.

- The 1:6-concept is judged, based on experience described above, not to have any safety advantages compared with 1:4. Only aesthetic reasons apply for the 1:6.

- A slope guard-rail concept is introduced to allow the implementation of modern guard-rail design in existing 1:3 inner slopes, basic principles given in Figure 3 with the lower part and upper part of the horizontal beam at the same height over the surface in the slope as should be the case on the carriageway. The design is tested and approved for capacity N2 in European standard EN1317-1 and 2 and the Swedish method VVMB 350 (ref 22).

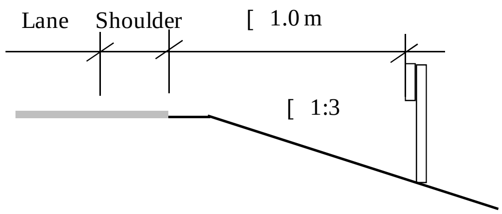


Figure 3 - Basic principles of the slope guard-rail.

- The traditional concept on termination lengths – to avoid crashes down to an encroachment angle of 8 degree in 90 kph and 6 degree in 110 kph **-** is judged to be basically wrong. A lot of severe accidents tend to be caused by drowsiness with very narrow encroachment angles stressing the importance of closing windows to decrease consequences of drowsiness accidents, see an example Figure 4.

Figure 4- Example of window shutting at guard-rail termination

- Full-scale and simulation tests focus on the risks vehicles to travers smooth cut designs with low back slope heights. It could be questioned if smooth designs are cost-effective in this case.

- The 2+1-review indicates median barriers to improve traffic safety in terms of severe and fatal accidents by some 40-50 % given motor cycle traffic volumes are constant.

3. PRESENT SPEED LIMIT REVIEW

Sweden was the first country in the world to introduce general speed limits in 1971. The default speed limit outside urban area became 70 kph. Given sufficient geometric standard the SRA DG has the power to increase the speed limit to 90 or 110 kph on longer section with a possibility for the regional state administration to decrease the speed limit at shorter sections due to local conditions such as an intersection with high traffic volumes on the secondary road or bad sight conditions or linear side friction.

The standard criteria at that time were road width and sight conditions giving 90 kph at widths over some 8 m roads and 110 kph for 13 m wide roads. Northern Sweden with low population density and long distances were excepted from these guidelines.

New criteria to be applied were introduced in 1997 with more modern requirements on roadside areas comparable with the design guidelines at that time recommending 5 m clear zones at 90 kph and 8 m at 110 kph (ref 11). In the early 2 000:ies some 10 000 km each were narrow (<6.5 m) and normal 90 kph two-lane roads. There were also almost 3 000 km narrow or normal two-lane roads with 110 kph speed limit. Narrow 90 kph roads and most 110 kph two-lanes were located in northern Sweden.

At present a major review of all Swedish speed limits is in process based on a parliament bill (ref 16). One of the principles in the overview is to require VGU roadside area standard for all roads with speed limits over the default speed limit with traffic volumes over AADT 2000 and median separation over 4000 (ref 19). The result predicted is 75 % of all two-lane roads with speed limits 90 and 110 kph to be decreased 10 kph and for 110 kph roads, in some cases with 20 kph. Given design improvements during the first three years of the next investment plan 2010 to 2021 speed limits are not changed.

This will create a big national scheme with roadside improvements. It will be of outmost importance with good guidelines on cost-effective measures.

4. EMPIRICAL FINDINGS ON ROADSIDE DESIGN

A number of efforts have been carried out since the VU94 -introduction in order to estimate safety effects of alternative roadside area treatments and to improve design of roadside areas and guard-rails. The objective here is to summarise findings as yet:

- Accident analysis on motorways with different roadside area types
- In-depth analysis of median accidents on E4 and E6 new sections
- In-depth analysis of single run-off barrier crash accidents on motorways
- The bus accident on E18/20
- Single run-off accidents on two-lane roads with speed limit 90 kph
- Follow-up study roadside area treatment in the Scandia region
- Full-scale and simulation test alternative roadside area designs
- Motor cycle accident study on median barrier 2+1-roads

Engineering judgement of these studies create the structure for changes in strategy for roadside area design shortly described in the proceeding chapters.

4.1 ACCIDENT ANALYSIS ON MOTORWAYS WITH DIFFERENT ROADSIDE AREA TYPES

The VU 94 guideline (ref 10) was the breakthrough for the soft slope concept in Sweden though partly practised before. The overall effect on severe accidents had been estimated to be some 20 % based on the assumption all severe single run-offs to be smoothed to light injuries.

In 1999, the first empirical evaluation of expected traffic safety effects could be carried out. Accident data for October 1993 until September 1998 were combined with an inventory of roadside area standards described roughly as old (1:3), average (1:4) or modern (1:6). The inventory was done by the SRA regional offices in a rather rough mode.

The data set holds almost 1 200 km motorways with 127 fatalities and 683 severe injuries see Figure 5 for details. 400 km of these motorways were judged to have basically modern design with 1:6 slopes or modern guard-rails. The “with-without” comparison gave positive significant F-test results with 25 % lower fatal and severe injury rates for single run-off accidents. The total effect was judged to be some 22 % lower. These results tend to support the previous hypothesis based on simple arithmetic on historical accident data and results from simulations on different slope and barrier designs.

	AADT	L km	Speed	Traffic load	Killed	Severe	KS-rate 2)		K-rate 2)		Cost/accident 3)	
Type	mean	tot	mean	Mill apkm	no 1)	no 1)	tot	run-off	meeting	total	run-off	all
110 modern	12886	432	114	7646	13	115	0,017	0,009	0,0003	0,0017	815	882
110 average	13306	146	0	3229	18	67	0,026	0,014	0,0028	0,0056	1147	1249
110 old	22400	527	113	24314	81	425	0,021	0,012	0,0010	0,0033	1032	928
110-C <20	15139	274	114	8462	39	138	0,021	0,013	0,0019	0,0046	1089	1073
110-?	11705	12		252	1	2	0,012	0,012	0,0000	0,0040	1353	919
E4 new	8860	97	116	1029	1	24	0,024	0,014	0,0000	0,0010	1245	1266
E6 new	14291	72	114	1522	2	20	0,014	0,011	0,0007	0,0013	1005	846
110 all	17412	1118	113	35441	113	609	0,020	0,011	0,0010	0,0032	1000	948
90 modern	72000	1		199	1	4	0,025	0,015	0,0000	0,0050	5646	1065
90 old	38723	46	96	3595	8	42	0,014	0,008	0,0006	0,0022	821	634
90-?	39213	18		1509	5	28	0,022	0,009	0,0013	0,0033	1279	1022
all	18636	1183	113	40744	127	683	0,020	0,011	0,0010	0,0031	999	918
1) period Oct 1993 to Sept 1998			2) per Million axlepairkm			3) killed 14,3 Million SEK, severe 6,2 Million level 1996						

Figure 5 - Accident, speed and traffic data Oct 1993 until Sept 1998 Swedish motorways with various roadside area design.

4.2 IN-DEPTH ANALYSIS ON NEW SECTIONS ON E4 AND E6

A more detailed analysis was carried out for the new E4 motorway sections in the Jönköping county with a 13 m wide median with 6 m inner and 6 m outer 1:6 slopes with a 1 m strip in between and for the new E6 motorway sections in the Halland county with a single modern barrier (sometimes double W-beam, sometimes wire rope) in a 4 m 1:4 shallowed median (ref 13). The average AADT on the E4 section is close to 9 000 veh/day and on the E6 approximately 14 000 veh/day. The E4 mean speed was slightly over 115 and the E6 slightly below 115 kph at a speed limit of 110 kph.

The E4 with a wide median had a fatality and severe injury rate almost double the E6, see Figure 7. The E4 had 16 median related accidents with severe or fatal consequences. 8 accidents included vehicles crossing the median and 14 vehicles turning over. The E6 figures were only 4 median related, no through passes and only 6 turn-overs.

A typical E4-accident is illustrated in Figure 6. The driver loses control at rather high speed and encroaches the median in a rather narrow angle. The 1:6 back slope operates like a ramp and the vehicle flies over the opposing carriageway, turns over and crashes badly.

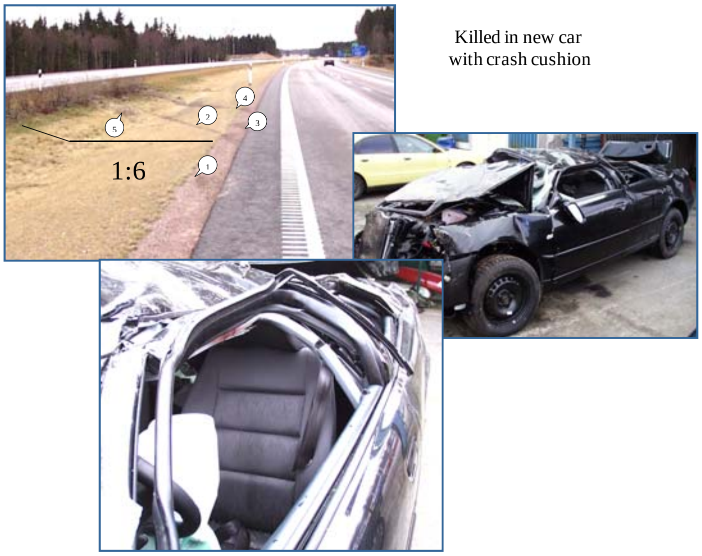


Figure 6 - Typical severe wide 1:6-sloped motorway median accident from E4 Jönköping county

Another typical wide median accident occurred on the E18 (ref 12). Again a drowsiness related accident. In this case, the shallowed median, with a very narrow encroachment angle, worked like a track causing the vehicle to drive almost 300 m before an abutment at an underpass gave a very violent crash.

The conclusion drawn in design guidelines for future projects is to recommend median barriers and to drop the wide median. Most new motorways with wide medians have been up-dated with barriers. This has also been done for all motorways build in the 80:ies and earlier with 4 m medians without barrier. The barrier design is often N2 rope wires due to investment costs and estaethic aspects.

4.3 IN-DEPTH ANALYSIS OF MOTORWAY SINGLE RUN OFF ACCIDENTS WITH AND WITHOUT BARRIER INVOLVED

All motorway single run-off accidents for the period Jan 1997 until Nov 1998 were analysed by means of the SRA accident data base (ref 13). Consequences could be stratified due to the presence of a barrier in the event process according to the police report, see Figure 7.

	Accident numbers						Per police reported acc.			Cost/acc kSEK	
Barrier 1)	injury	DO 3)	DO/Inj	Killed	Severe	Light	Killed	K+Severe	Injury	incl DO	excl DO
- yes	1062	809	0,76	20	51	282	0,019	0,07	0,33	731	663
- no	3195	2045	0,64	48	311	1267	0,015	0,11	0,51	1019	961
- all run-off	4257	2854		68	362	1549	0,016	0,10	0,46	947	887
110 modern 2)	829	566	0,68	8	60	319	0,010	0,08	0,47	787	725
110 old 2)	2705	1766	0,65	53	231	998	0,020	0,10	0,47	1001	942
1) Jan 1997 until Nov 1998; yes barrier involved				2) Oct 1993 until Sept 1998					3) DO=damage only		

Figure 7 - Accident consequences in motorway single run-off accidents with and without barrier crash

The data set contained over 4000 accidents; 25 % of these involving a barrier. Comparisons were also made with the data set for motorways with alternative roadside area standard. “Barrier” single run-off crashes on motorways and single run-off crashes on modern roadside areas have similar costs per accident and probability for a serious injury. They are both some 30 % lower than related values for single run-offs without barrier involved and single run-offs on older roadside area designs. An interesting observation was the fact that a majority of severe barrier accidents were preceded by driver manoeuvres creating large impact angles. Common event processes were run-offs to the right with panicked wheel movements throwing the vehicle out on the carriageway again crashing the median barrier.

These results support the conclusions described above on the advantages of barriers and smooth designs.

4.4 THE E18/E20 BUS ACCIDENT

A very serious bus single run-off accident occurred on the E18/20 motorway between Arboga and Köping in January 2006 (ref 17). The motorway section was opened only a few years earlier. The accident spot was located on a 4.5 m fill with the recommended broken design with 6 m 1:6-slope followed by a 1:3-slope. The speed was slightly over 100 kph and the weight close to 20 tonnes. The section was tangent with a slight up-grade and 2.5 % crossfall.

The driver looses control of his vehicle, probably due to an acute illness. The bus encroaches the slope with an angle of some 8 degrees. The the 1:6-slopecis traversed with ground contact for both front and boggie wheels. Entering the 1:3-slope the back part is pressed more downwards than the front part. The bus has still ground contact on all wheels colliding with an earth stone at the end of the filling and turns over directly, see Figure 8. The bus roof collapses and 9 people are killed.

Figure 8 - Visualisation of accident process at the E18/20 bus accident

The Swedish Crash Commission and SRA have analysed the accident giving the following conclusions:

- the actual speed, 107 kph, gives an movement energy some 40 % higher than given by the allowed speed limit for buses of 90 kph. It is important to continue and strengthen efforts to improve professional drivers understandig of and respect for speed limits

- a standard Swedish guard-rail with capacity class N2 according to the European standard EN 1317-2 should not have been able to avoid the disastruous accident. A H2 guard-rail, 4 to 5 times more expensive should have been needed.

- A more general use of higher capacity classes is not recommended. An analysis of the frequency of severe accidents with cars and heavy vehicles involved imply the cost difference to be too big to defend a more general use of the much more expensive H2-barriers. Higher capacity should only be applied based on site specific risk analysis.

- Broken fill slope design should be dropped from the guidelines.

- It should be advocated in the guidelines to avoid fill ditches. If needed due to constructions reasons crushed stone filling should be used.

4.5 SINGLE RUN-OFF ACCIDENTS ON TWO-LANE 90 KPH ROADS

Single run-off accident data for two-lane 90 kph roads for 1992 to 2002 were studied (ref 18). Data gave information on road width, traffic flow interval and number of fatalities, severe and light injuries for each traffic flow interval. The aim of the study was to analyse how accident rates by consequence, cost and accident type vary with two-lane cross-section width and traffic flow. Cross-section widths were divided in the groups narrow (below 5.6 m and 5.7 to 6.6 m), normal (6.7 to 7.9 m, 8 to 10 m and 10.1 to 11.5 m) and wide (over 11.5 m). The following main conclusions were drawn:

- Below AADT in the interval around AADT 3-4000 single run-off accidents tends to be the major problem.

- The single run-off accident rate (accidents damage only included per Million axle pair km) is higher for more narrow roads (below 8 m) with an average rate of 0.13 compared with 0.105 for wider roads see Figure 9. It might be argued that wide two lanes are slightly worse than 8 to 10 m. There is no pattern indicating any relationship with traffic flow. A reasonable hypothesis would have been a decrease as alignment standard probably improves with increasing flow

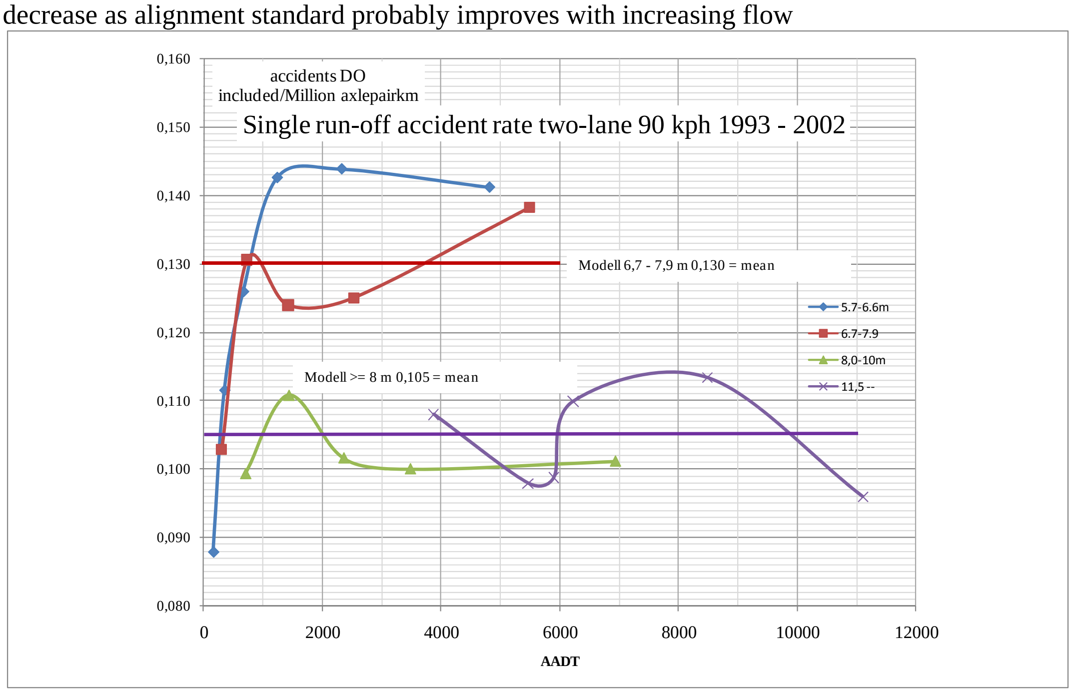


Figure 9 – Single accident rate versus traffic flow and cross-section width, two-lane roads 90 kph 1992-2001

- The single run-off accident cost has a very strong relationship with traffic flows with cost decreasing well fitted with negative exponential curves with high R2-values, see Figure 10. Narrow roads tend to have higher and 8-10 m lower costs than wide two-lanes. It is obvious that a lot of money has been spent over the years to improve roadside areas in Sweden more the higher traffic flows are.

The result is that a road with a traffic volume around 2000 veh/day has an average accident cost per run off around 2.2 Million SEK to be compared with a road with 10 000 veh/day with a halfened accident cost. These evidences are even more convincing when looking at the same graph, see Figure 11, for the consequence indeed, i.e number of fatalities and severe injuries per single run-off accident. Again a tendency could be seen 8 to 10 m having better score than wide two lane

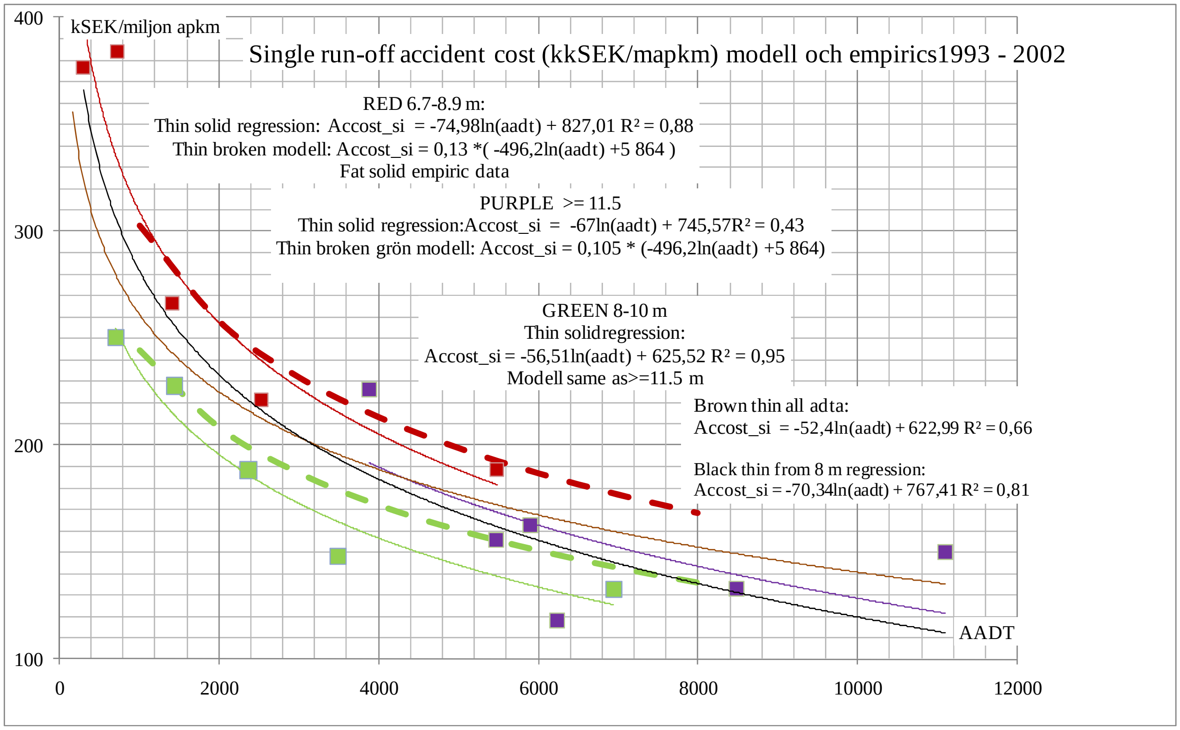


Figure 10 – Single accident costs versus traffic flow and cross-section width, two-lane roads 90 kph 1992-2001

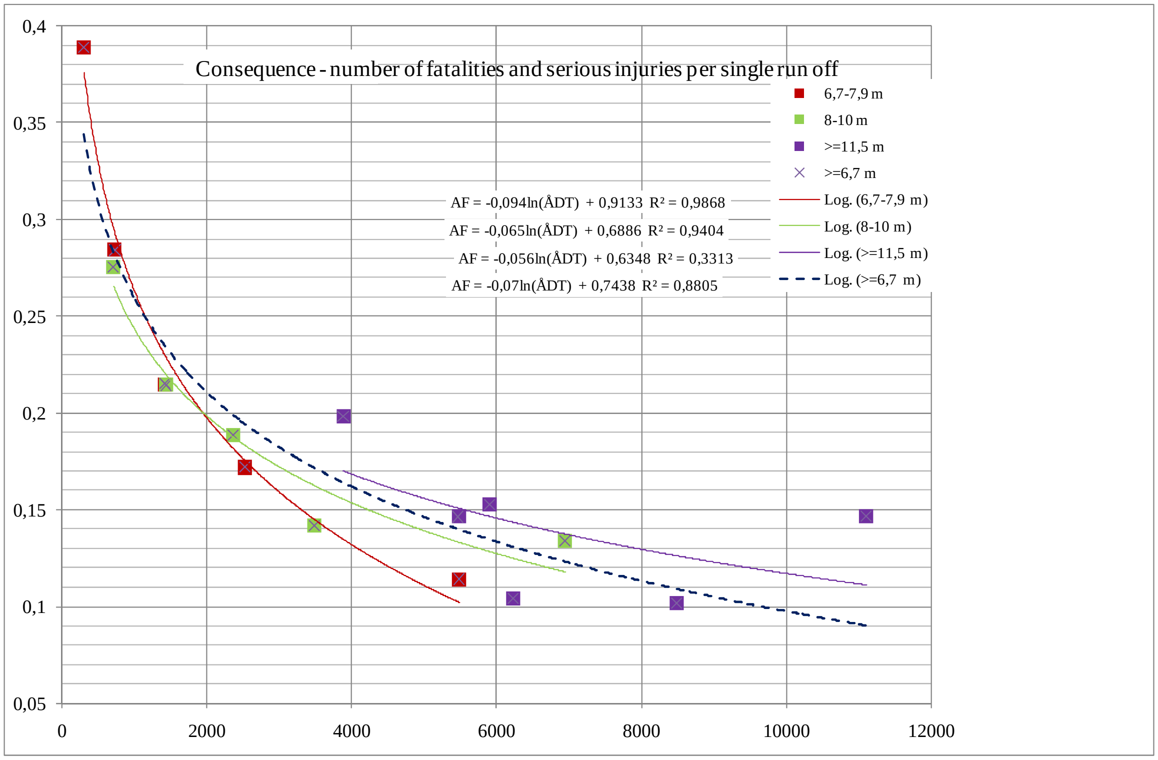


Figure 11 – Number of fatalities and severe injuries per single run-off accident versus traffic flow and cross-section width, two-lane roads 90 kph 1992-2001

4.6 FOLLOW-UP STUDY ROADSIDE MESAURES IN THE SCANIA REGION

19 roadside improvement projects performed during the period 1998 to 2002 were invented and classified into the five measure categories; from guard-rail implementation only to full treatment (ref 20). The average pre-period was 9.5 years and the average after-period 7.2 years. The following conclusions were drawn based on the data:

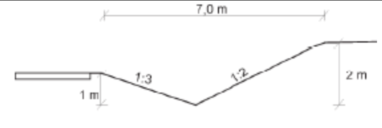
- the total reduction of fatal and severe injuries was 20 % with 29 % for the motorway projects and 14 % for the other road categories. This could be compared with a general decrease of 16 % for this period.
- the total reduction for single run off accidents was 52 % with 60 % for motorways and 43 % for other road types.

Average costs were € 10/m for motorways and € 20/m for other road types. The survey also found problems to identify recommended measures from the feasibility study, construction document and real measures performed.

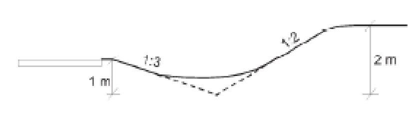
4.7 FULL-SCALE TESTS AND COMPUTER SIMULATION ALTERNATIVE ROADSIDE AREA DESIGN

A number of full-scale tests and computer simulation analysis have been carried out in a joint Scandinavian project (ref 2, 3, 21).

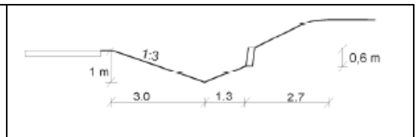
16 crashes were performed in Finland in three types of soil cuts, 14 of these in a traditional V-shape, one in a U-shaped and one with a back slope concrete wall as shown in Figure 12 below. Four crashes were carried out in Sweden, two in a traditional V-shape and two in a U-shape.



Traditional V-shaped 1:3/1:2 with 2 m high back slope



U-shaped ditch otherwise same geometry



Concrete back slope wall

Figure 12 – Full-scale test designs

Four tests according to the EN 1317-3 standard were also performed to test a Finnish proposal to smooth an access road culvert by means of logs with questionable result.

Approach angles were around 4, 10 and 20 degrees, vehicle mass 900 and 1500 kg and speeds approximately 60, 80 and 100 kph, see Figure 13 below. The V-shaped ditch caught the vehicle in a reasonable way at narrow impact angles but bigger impact angles tend to create situations where the vehicle turned over or traversed the 2 m back slope. The U-shape also made the vehicle traverse the back slope.

Vehicle	Mass	Speed	Impact angle	Max height in back slope	Crash backslope	Trajec-tory	Roll over	Design
Talbot Horizon	900	96	10	>2	not reg.	beyond	no	U
Ford Fiesta	908	80	10	not reg.	no	on top	no	U
Volvo 244	1453	81	10	not reg.	no	beyond	no	U
Peugeot 205	900	78	3	0.2	not reg.	in ditch	no	V
Peugeot 205	900	84	4	2	not reg.	in ditch	no	V
MB200 D	1500	81	4	1.6	not reg.	in ditch	no	V
Peugeot 205	900	102	6	1.4	not reg.	in ditch	no	V
Ford Fiesta	900	62	10	>2	not reg.	beyond	no	V
Peugeot 205	900	83	10	>2	not reg.	beyond	no	V
Talbot Horizon	900	100	10	>2	not reg.	beyond	no	V
Ford Fiesta	908	80	10	not reg.	yes	in ditch	yes	V
Volvo 244	1453	80	10	not reg.	yes	in ditch	yes	V
MB200 D	1500	82	10	>2	not reg.	beyond	no	V
Talbot Horizon	900	107	19	>2	not reg.	beyond	yes	V
Peugeot 205	900	79	20	2	not reg.	in ditch	yes	V
Talbot Horizon	900	82	20	2	not reg.	in ditch	no	V
Peugeot 205	900	82	10+steering	1.3	not reg.	in ditch	no	V
Fiat Ritmo	900	82	11+steering	1.2	not reg.	in ditch	yes	V
Ford Fiesta	900	81	9+steering	inner slope 0.5	not reg.	back to road	no	V
Peugeot 205	900	105	10	0.6	not reg.	in ditch	yes	V+C

Figure 13 - Summary full-scale crash test results

74 simulations were performed with the LS-Dyna and the Dy-mesh softwares with:

- Vehicle masses 900, 1500 and 20000
- Impact speeds 80 to 130 kph
- Impact angles 5, 10, 15 and 20 degrees

- Two soil types with 100 and 200 mm rut depth
- Various types of V- and U-shapes with a two meter high back slope
- Fill slopes 1:3 and 1:4

The following conclusions and recommendations were made for soil cut designs:

- U-shaped ditches increases the risk for traversing the cut
- V-shaped ditches increases the risk for back slope crashes and turn overs
- The recommended designs are 1:3 slope with short cut and culvert for drainage

There were surprisingly no differences in the assessment of 1:3 and 1:4 slopes at 4 m fill.

4.7 MOTORCYCLE ACCIDENTS IN MEDIAN BARRIER CRASHES

VTI's follow-up study on median wire-ropes barrier includes a detailed analysis on motor cycle accidents on these roads (ref 1). A comparison of ratios of motor cycles involved in severe and fatal accidents on wire-rope roads and other roads claim a 40 to 50 % reduction for motor cycle drivers. The Swedish motor cycle organisation‘s opinion is explained because it is so dangerous to drive on these roads that nobody dares. In-depth studies of fatal motor cycle accidents on wire rope roads as yet have not found one case claimed to be caused by the rope. In-depth studies generally claim the post to be the problem for motor cycle drivers. Wire ropes nowadays have smoothed pole designs and no hooks to improve performance in case of motor cycle incidents.

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