IRDES

Questionnaire roadside safety interventions and their effectiveness

Final Report

May 2011

Università degli Studi di Firenze (UNIFI, Project Coordinator)

ÖFPZ Arsenal GmbH (AIT)

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Author(s):
Eleonora CESOLINI, ANAS, Italy
Federica Roberta BIANCHIN, ANAS, Italy
Raffaella GRECCO, ANAS, Italy

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1 Introduction

Following a specific request by ERANET SRO1 Programme Executive Board (PEB) a specific Work Package (WP) has been established within the IRDES Project devoted to preparing, circulating and analysing the results of a survey among the different European Road Administrations concerning the safety interventions used to improve roadside design and their estimated effectiveness.

The questionnaire was distributed to several National Road Administrations covering all European countries mainly through the Conference of European Road Directors (CEDR) in order to reach mainly national authorities in charge of the national road network.

The National Road Authority that answered the questionnaire are:

COUNTRY
Austria
Belgium
Estonia
Finland
France
Germany
Iceland
Ireland
Italy
Lithuania
Luxembourg
Malta
Poland
Slovenia
Sweden
The Netherlands

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- Assessment of implemented interventions
- New solutions for roadsides

2 General questions

The first part of the questionnaire includes general questions about the length of the road network (divided in motorways, highways single/dual carriage and others) as well as type of roadside implemented interventions.

The overall distribution the different road types for which the responses are provided (Figure 2.1) show that the vast majority of the network considered refers to single carriageway rural highways (76%(with only 12% referred to dual carriageway highways or motorways and 12% of other type of roads.

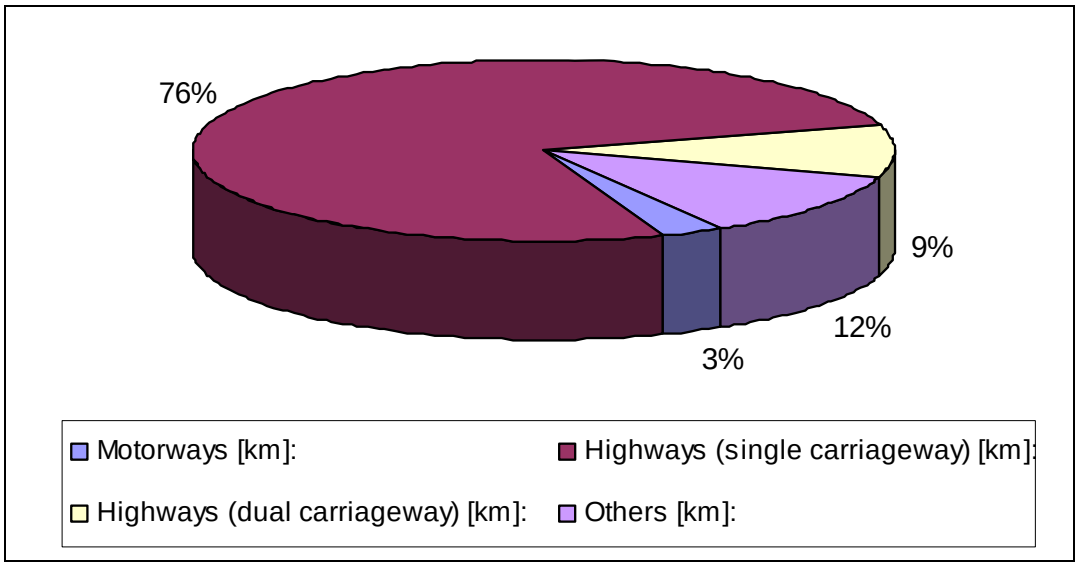


Figure 2.1: ***Length of network by road for all countries***

3 Roadside treatments

3.1 Roadsides protected with safety barriers

One of the questions concerned the conditions in which safety barriers are used to protect the roadsides. In Figure 3.1 percentage of road network protected with safety barriers by Country and by road type is shown. In Figures 3.2 and 3.3 the use of safety barriers for protecting different road configurations (embankments, cutting, bridge roadsides and tunnel roadsides) is shown. It is interesting to note that some countries (Belgium and Sweden) always protect tunnel roadsides with safety barriers while come others (Finland and Poland) often do not protect bridge roadsides with safety barriers. .

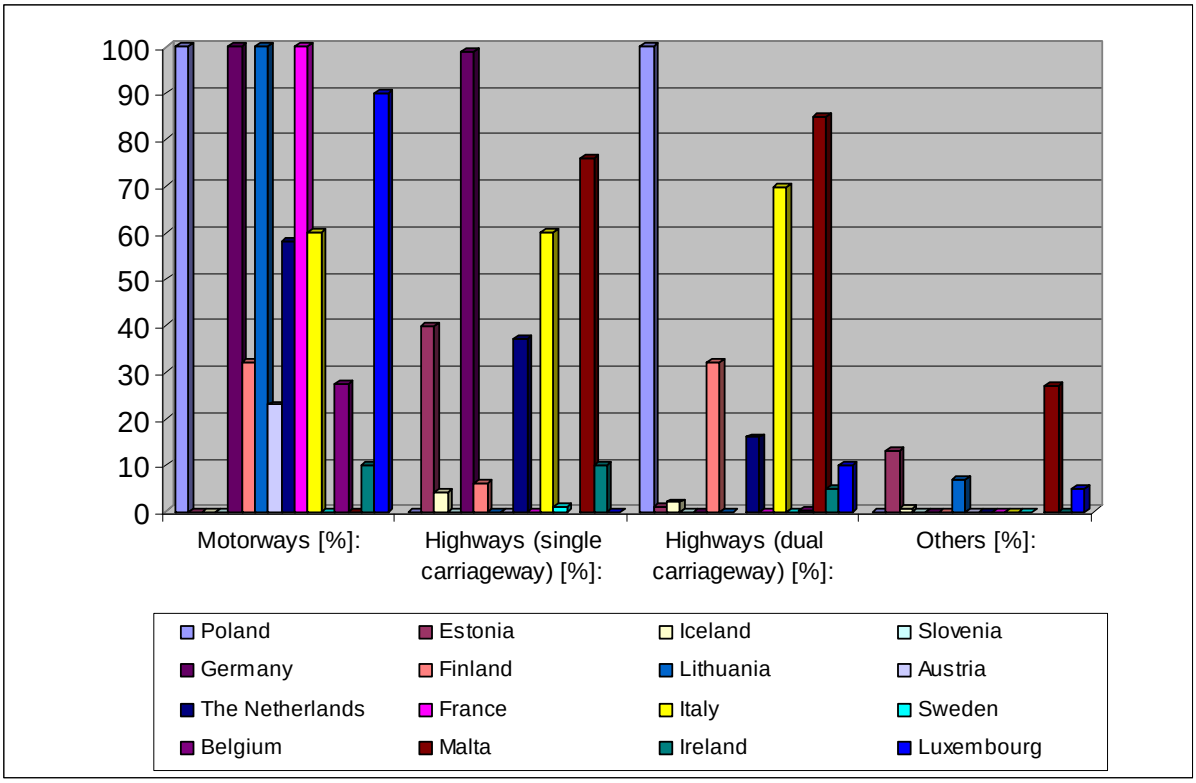


Figure 3.1: ***Roadsides protected with safety barriers for all countries***

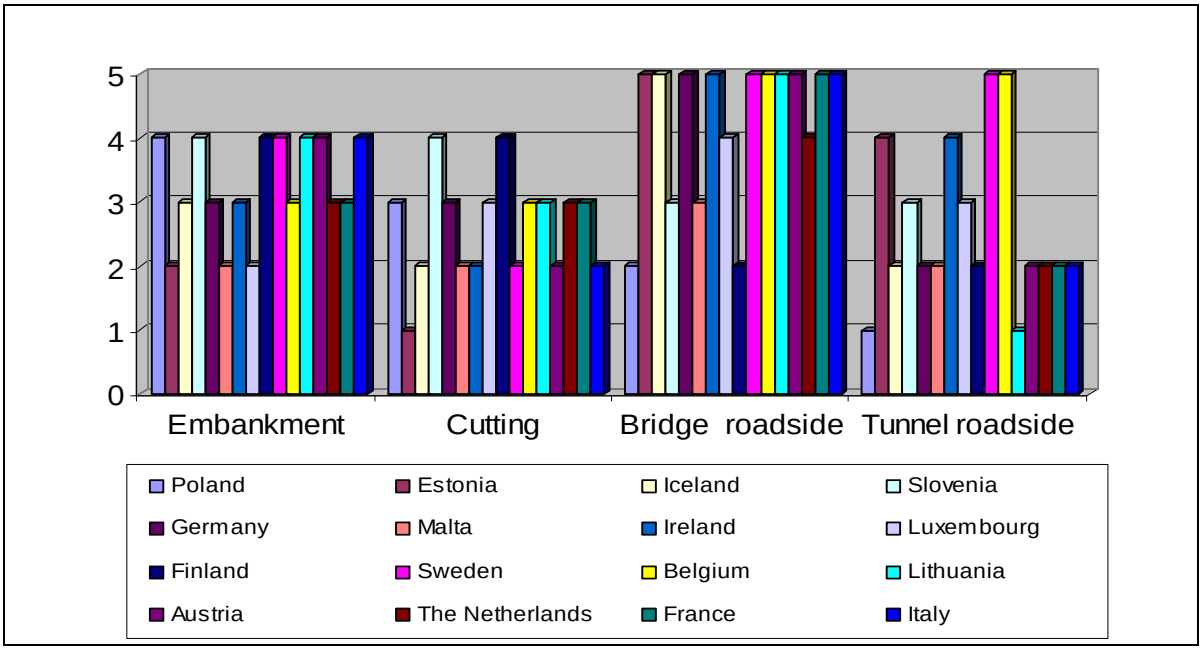


Figure 3.2: ***How often they are protected with safety barriers***
(1 never, 2 not often, 3 quite often, 4 often, 5 always)

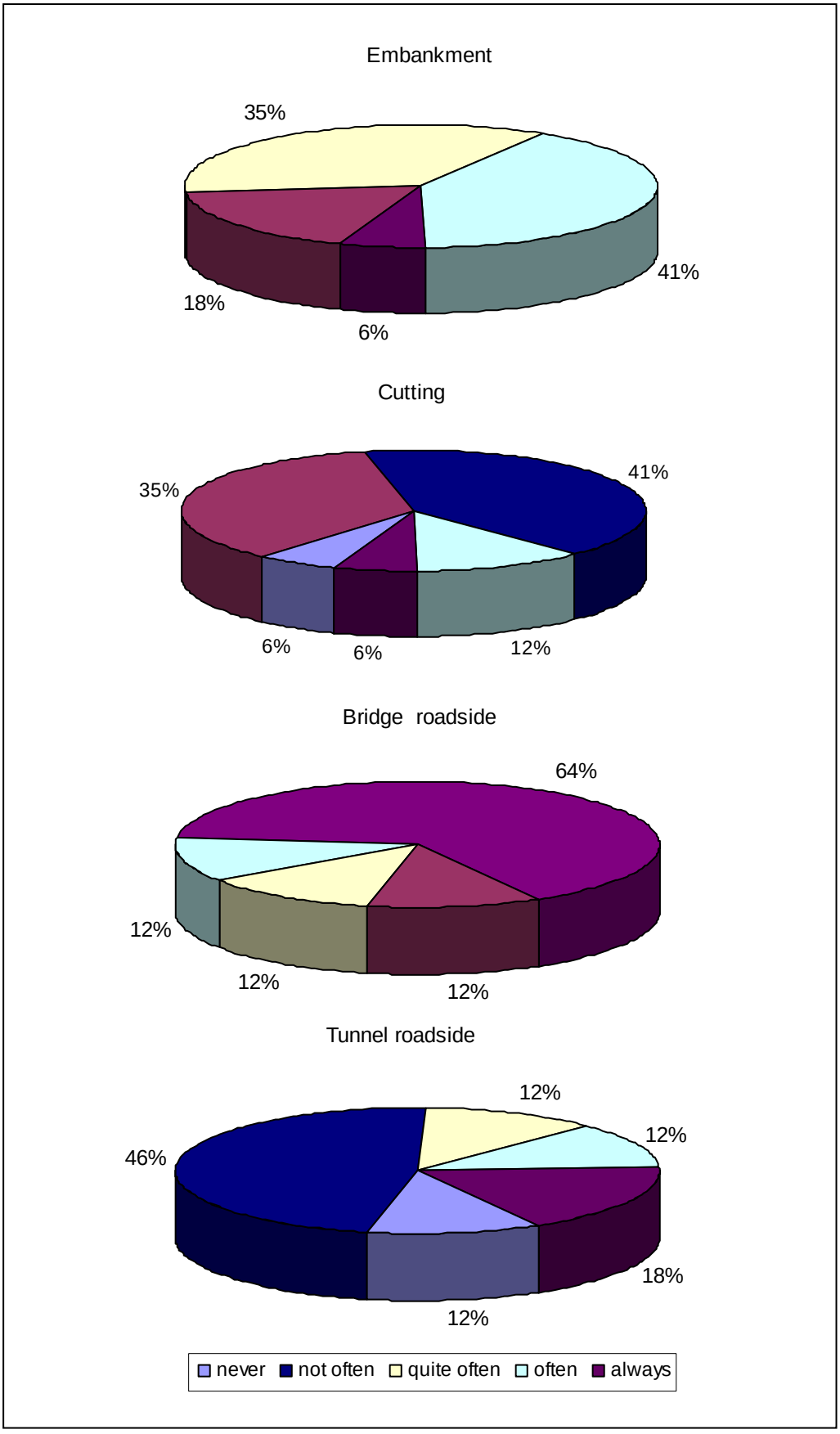


Figure 3.3: ***How often they are protected with safety barriers*** **by roadsides for all countries**

3.2 Horizontal signs

3.2.1 Special horizontal markings

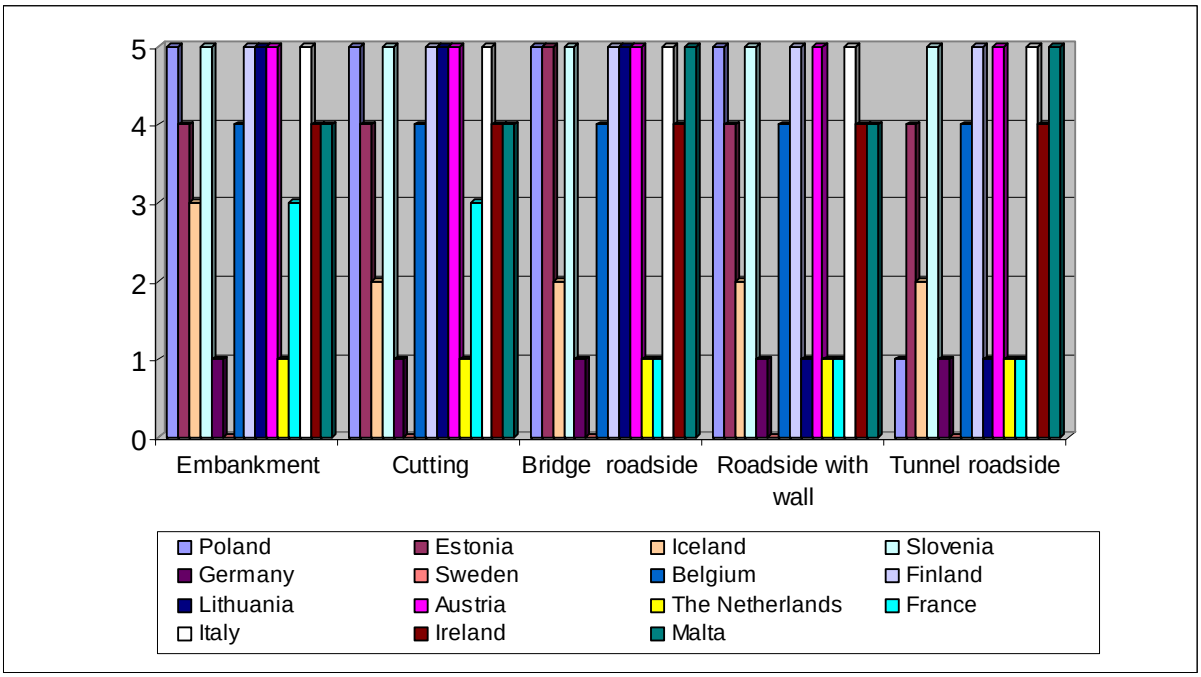
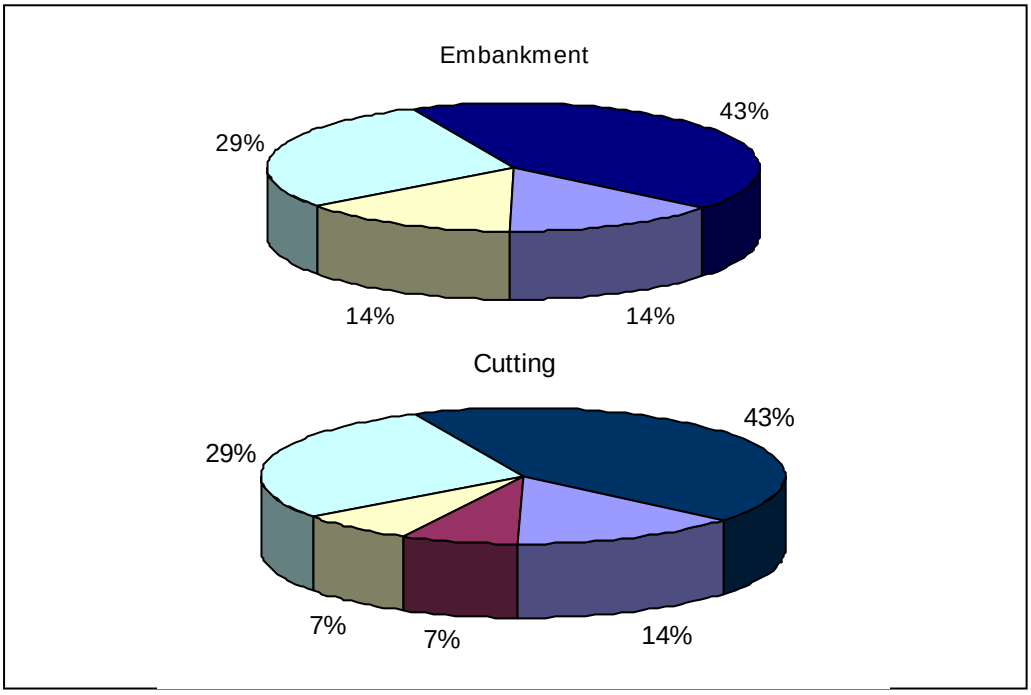


Figure 3.4: ***Use special horizontal markings on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section***
(1 never, 2 not often, 3 quite often, 4 often, 5 always)



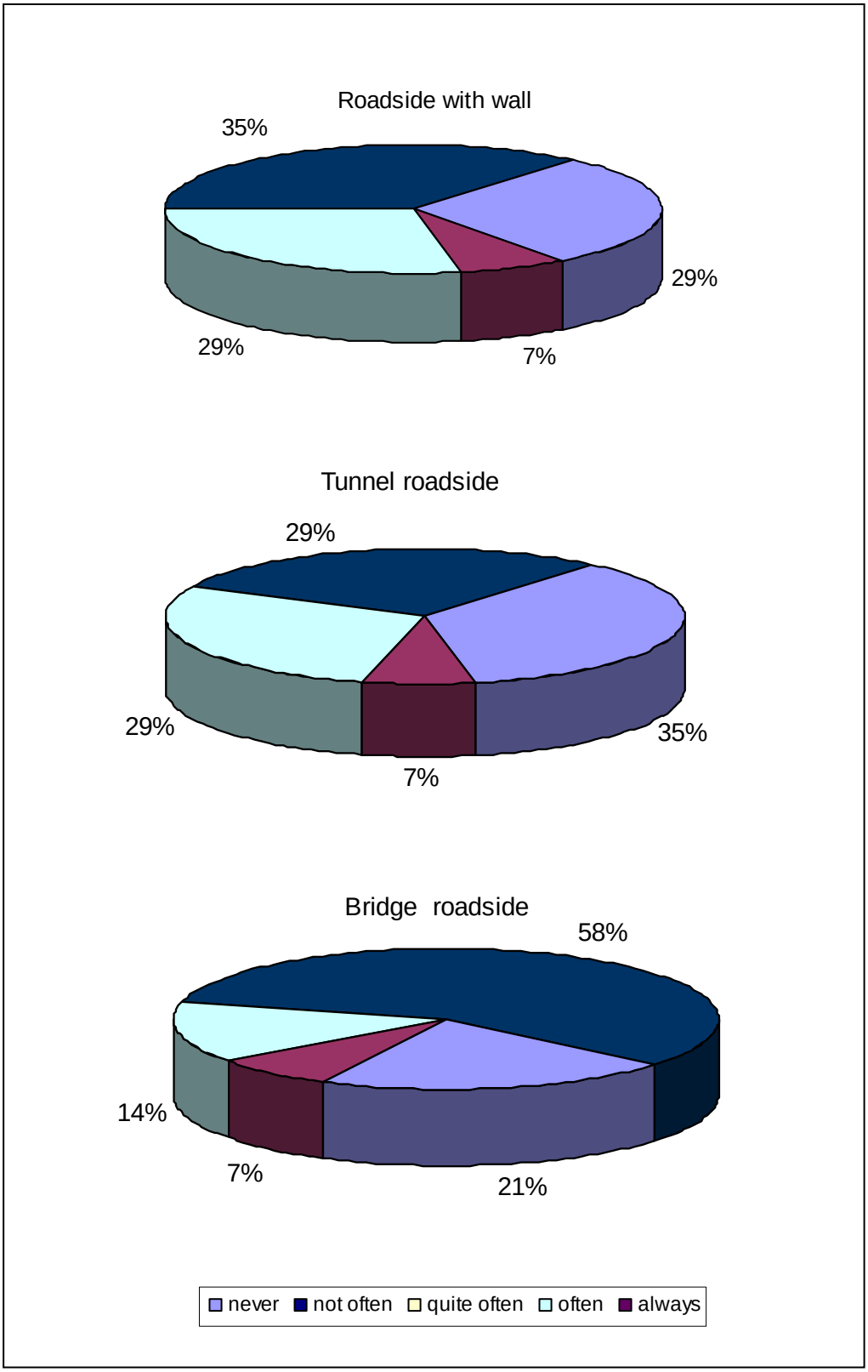


Figure 3.5: ***How often they are protected with special horizontal signs by roadsides for all countries***

3.3 Vertical signs

3.3.1 Special vertical signs

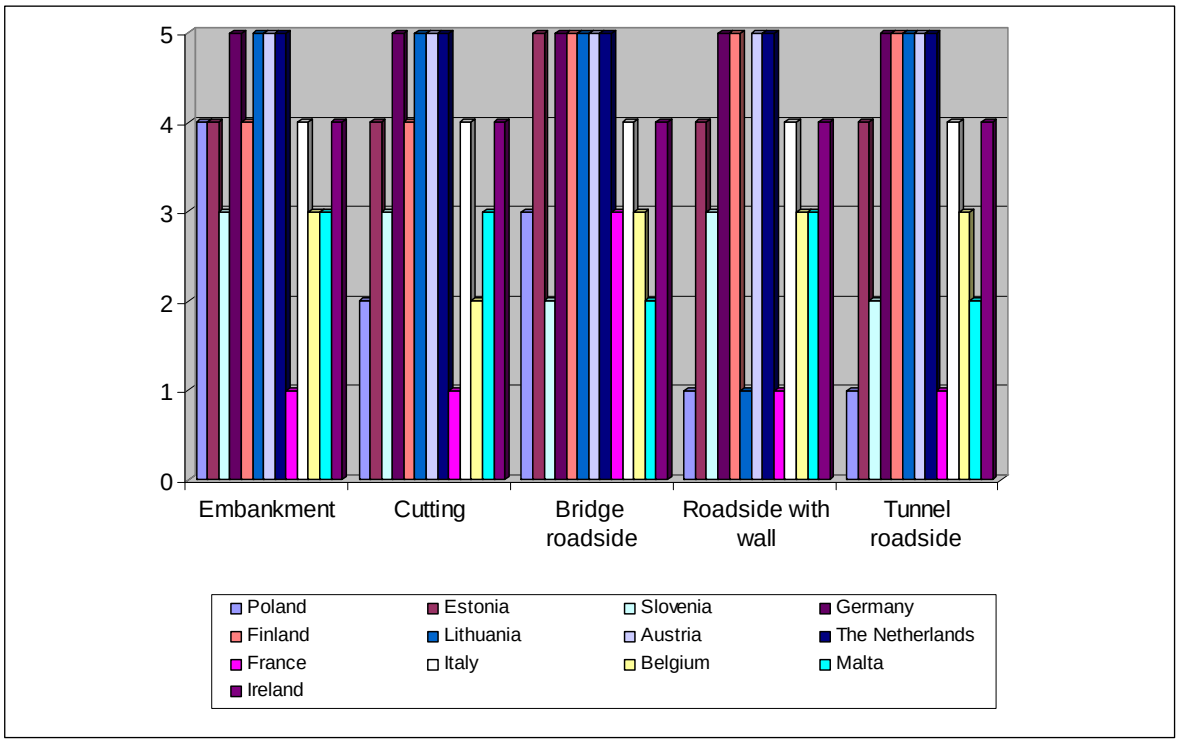
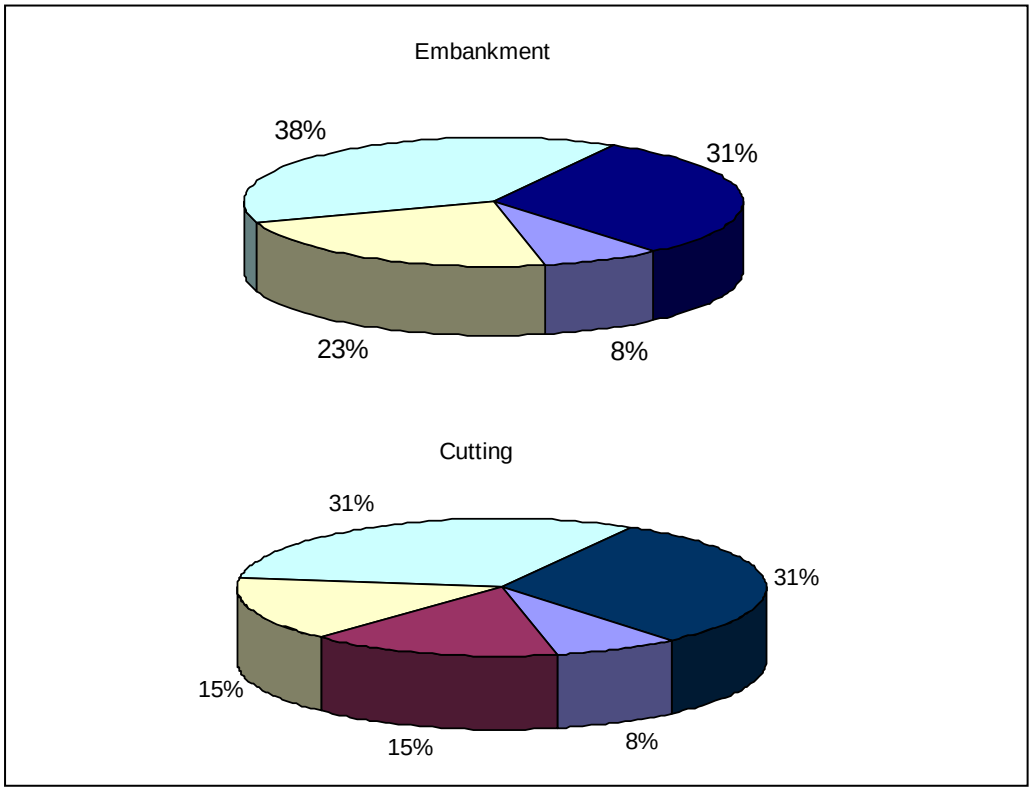


Figure 3.6: ***Use roadsides to highlight the road edge and obstacles***
(1 never, 2 not often, 3 quite often, 4 often, 5 always)



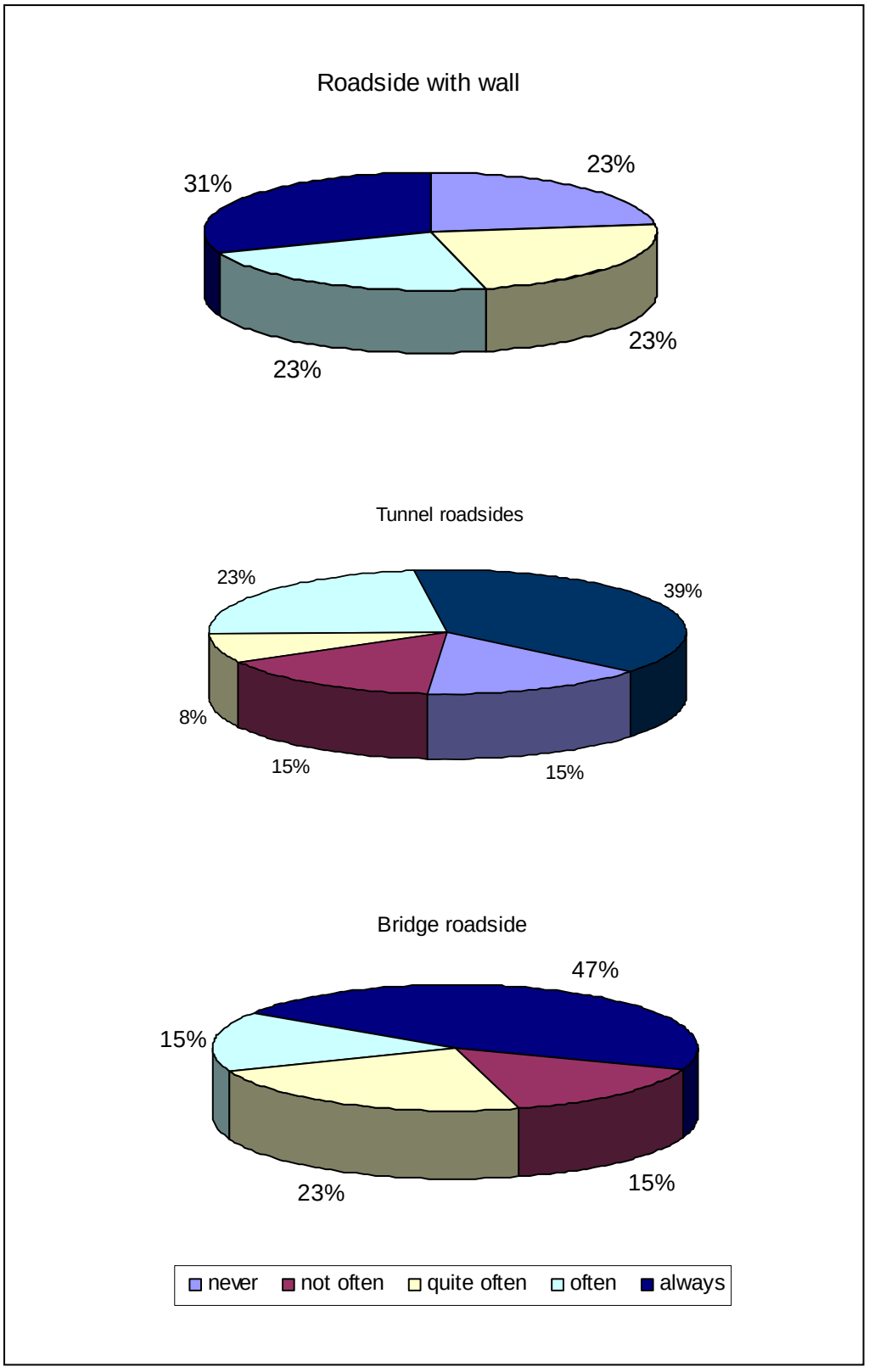


Figure 3.7: ***How often they are used on roadsides delineation to highlight the road edge and obstacles by roadside for all countries***

3.3.2 Other vertical signs

- ***Germany***, reflectors, Leds on kerbs, in tunnels;
- ***Iceland***, chevrons to warn drivers of sharp bends in tunnels
  reflectors on the safety barrier on bridges;
- ***Ireland***, vehicle Activated Signs with associated warning signals to
  alert drivers to sharp bends ahead or other hazards;
- ***Italy***, emergency lane, parking zones, SOS posts, high-impact sign, energy absorption system, rumble strips, in general. Special bridge barriers, wind protections, antiglare devices on bridges;
- ***Luxembourg***, repetition of signs along the road, automatic detection signs "danger" with flashes.

3.4 Type of interventions predominantly in the roads

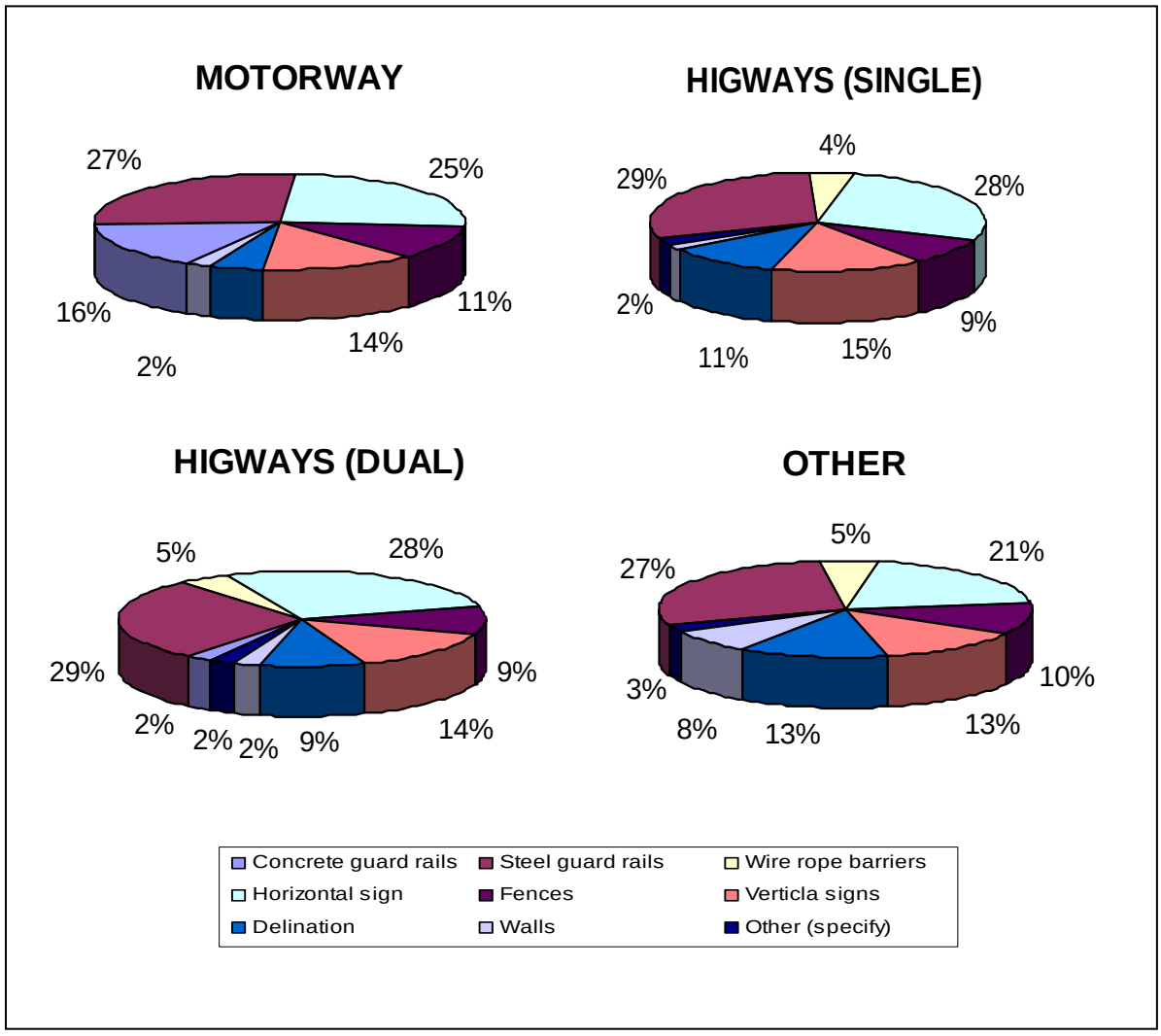
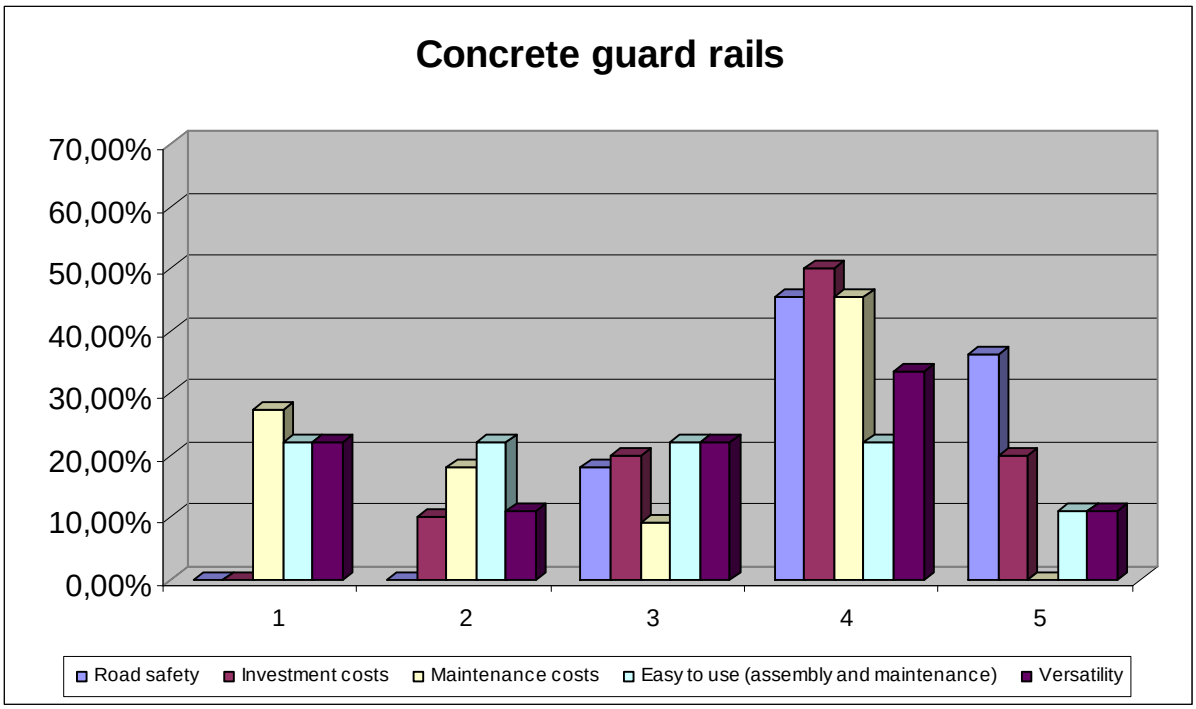


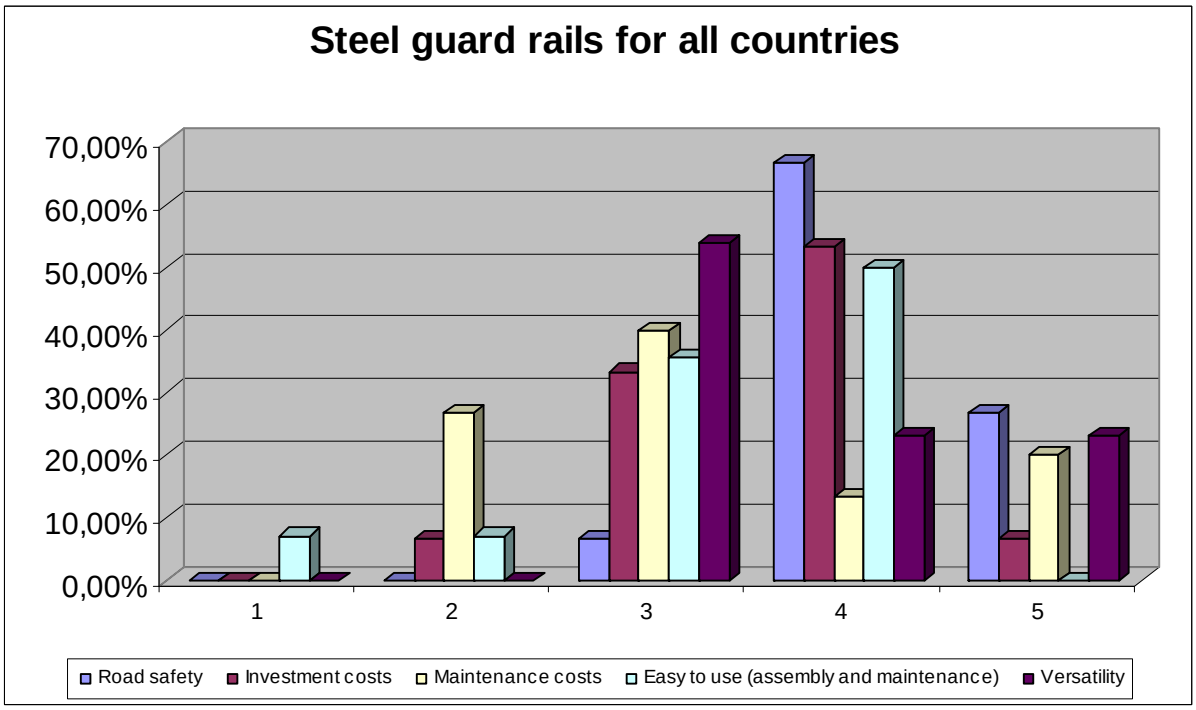
Figure 3.8: ***Type of intervention predominantly for all countries***

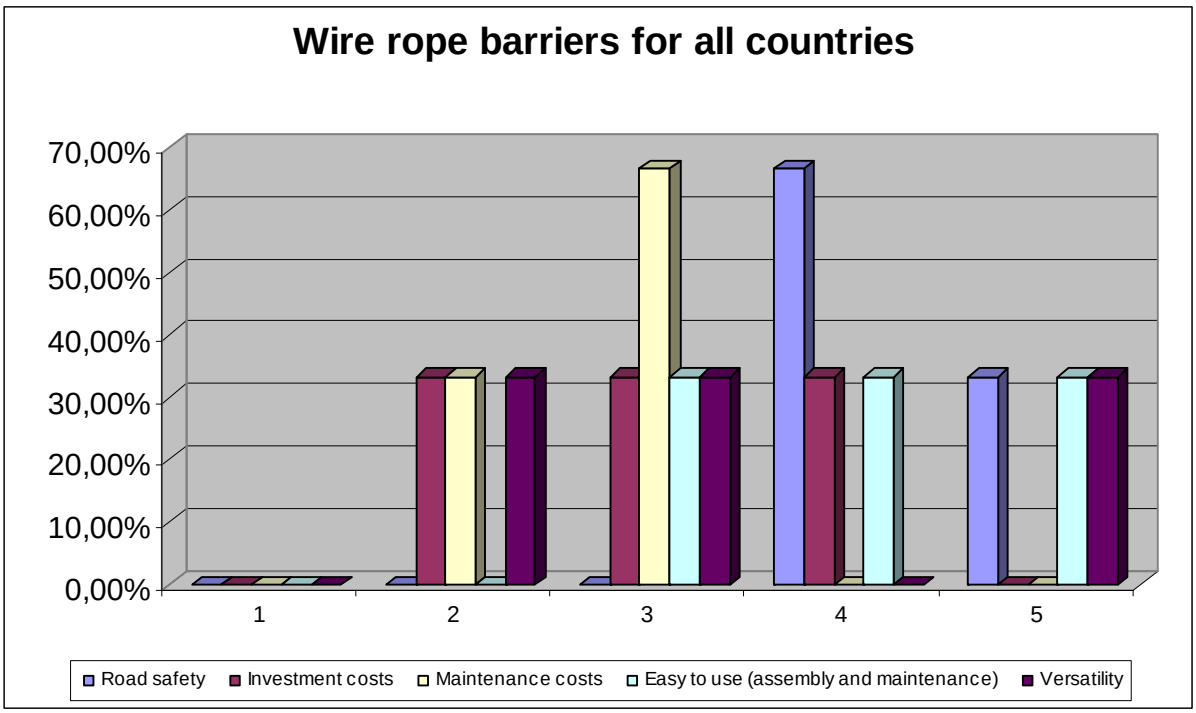
4 Assessment of implemented interventions

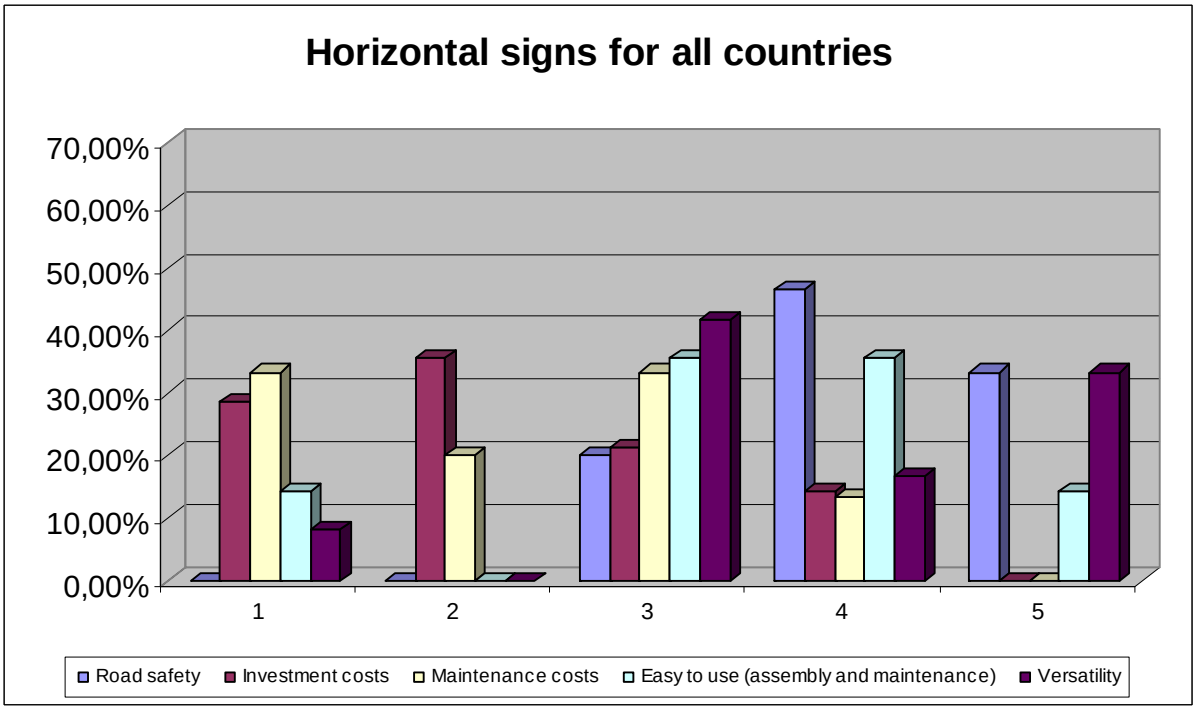
4.1 Type for intervention for all countries

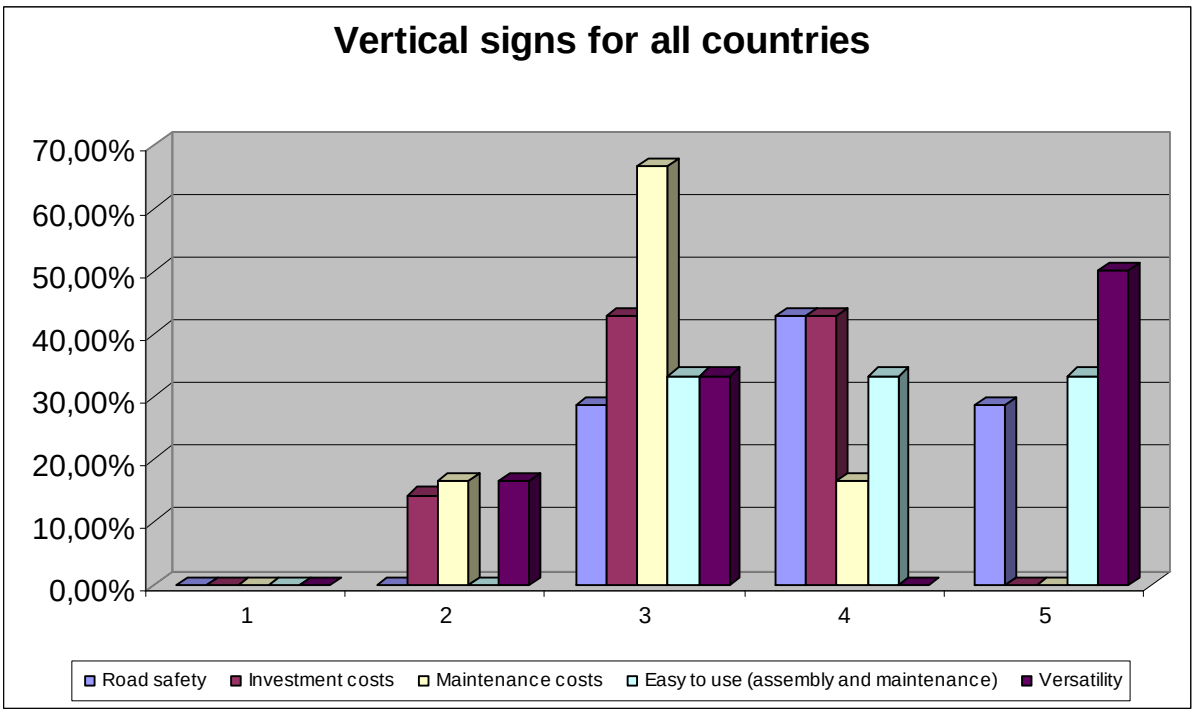
(1 low, 2 quite low, 3 enough, 4 quite high, 5 high)



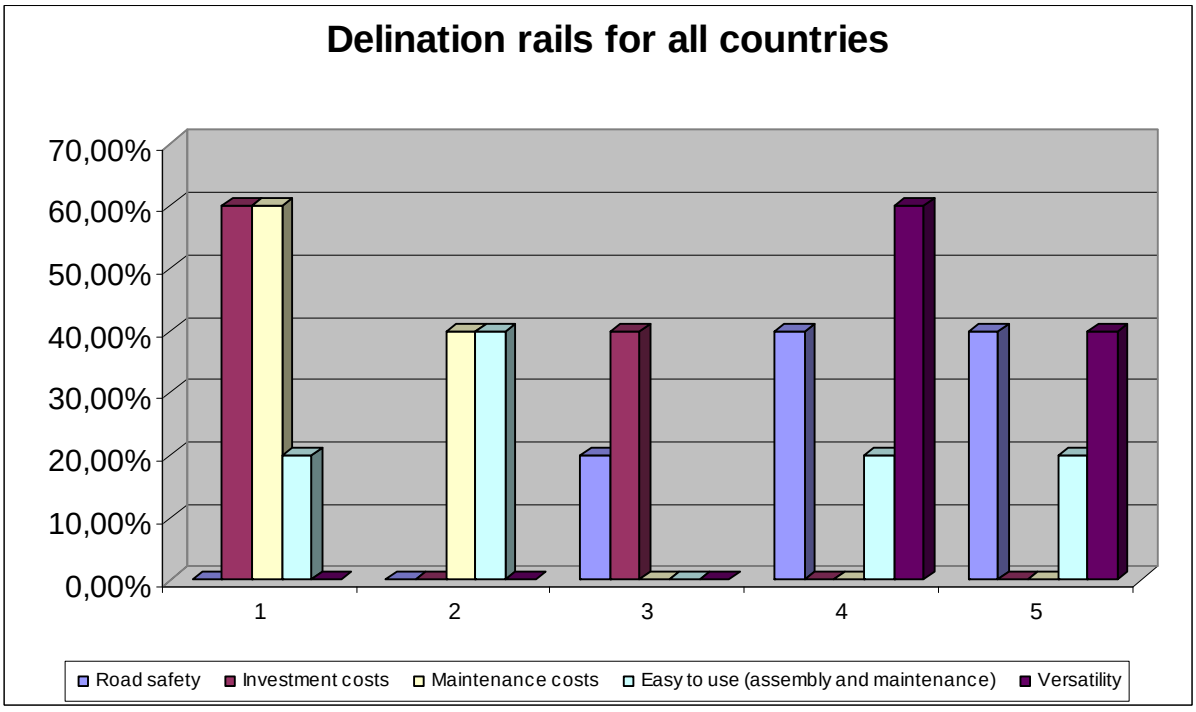



Wire rope barriers for all countries
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
1
2
3
4
5
Road safety
Investment costs
Maintenance costs
Easy to use (assembly and maintenance)
Versatility


Horizontal signs for all countries
70,00%
60,00%
50,00%
40,00%
30,00%
20,00%
10,00%
0,00%
1
2
3
4
5
Road safety
Investment costs
Maintenance costs
Easy to use (assembly and maintenance)
Versatility



1



2

[1] France, Germany, Luxembourg, Austria, Finland, Estonia, Iceland and ireland not answered.

[2] Austria, Belgium, Poland, Finland, Luxembourg, Lithuania, Malta and Slovenia not answered.

5 New solutions for roadsides

In this section of the questionnaire some innovative solutions have been submitted to the attention of Road Administrations. The following systems have been considered to evaluate their effective use and the possible willingness of the Road Administrations to use them:

5.1 Breakaway devices

A sign, traffic signal or lighting support designed to yield or break when struck by a vehicle.

There are several strategies to make poles or posts “forgiving”. This can be achieved by the following modifications:

• *Material use*: The most obvious way to increase the energy-absorbance is to use materials with low stiffness. A good compromise between energy-absorbance and safety are poles made of fibreglass that absorb the energy on its entire length. The pole cracks without having a predetermined breaking point.

• *Splicing*: in order to achieve a safe breakaway, splices should be kept close to the ground.

• *Slip-base poles*: A characteristic of slip base poles is that, when impacted at normal operating traffic speeds, they are generally dislodged from their original position. It enables the pole to slip at the base and fall if a collision occurs.

• *Breakaway transformer base*: A transformer base, commonly made of cast aluminum, is bolted to a concrete foundation. The bottom flange of the pole is bolted to the top of the transformer base. The aluminum is heat-treated to make it “frangible,” so that the pole can break away from the base when struck by a vehicle.

• *Breakaway poles (with breakaway connectors)*: When breakaway poles are used, the electrical conductors must also be breakaway. This is accomplished by using special pull-apart fuse holders (breakaway connectors).

Figure 5.1: ***Breakaway/spliced pole (left) and slip base (right)***

The use of breakaway poles, avoiding to protect them with safety barriers, is appropriate if they are small in size and in particular, as regards road signs, portal should not exceed 1 mq. In Italy fibreglass breakaway poles are also used, linked at the top by a steel cable that works as a safety connection when the pole is hit, more frequently in urban environment.

5.2 *Rumble strips*

A thermoplastic or grooved transverse marking with slight vertical profile which is designed to provides audible and tactile warning by the use of the ribs. It is normally located between hard shoulders and nearside travel lanes of carriageways. These are intended to help driver's attention in order to reduce the consequences of a run-off road event.

This solution, in different countries, is widely used to protect roadsides where the escaping vehicle is extremely dangerous, as for example it's used in Germany, while in Italy it's mainly used on roads with presence of fog.

The rumble strips were born as cross cuts of pavement then following with longitudinal or transverse in relief strips, but they were damaged by snow machines. Current solution consists in milling the roadside of pavement surface with variable thickness.

Figure 5.2: ***Example of rumble strips***

5.3 *False cutting*

It's defined a "false cutting" a treatment of the roadside embankment that creates a ground division between the road and the external environment so that the road appears to drivers just like a cutting and as a linear artificial hill that doesn't permit to see the road itself.

The advantage of this solution in terms of safety is to move up, from the paved surface, the potential obstacles present in the roadside. Trees, noise barriers and signs are located above the embankment created by the false cutting. The side of false cutting beside the road can be equipped with continuous barrier or with a light slope (if space is available). False cutting can be obtained during construction works (or even on existing roads) expanding and erecting embankment from the end of the shoulder; on this mound of earth we can put shrubs or trees or acoustic barriers (in case of roads inside built-up areas). Inside the hill thus obtained, pipelines for rain water management and / or for treatment of air coming from vehicles can be placed. Non continuous safety barriers for this roadside are unnecessary, since the fall from embankment is impossible. Continuous barriers or redirecting profiles can increase safety provided this kind of sections.

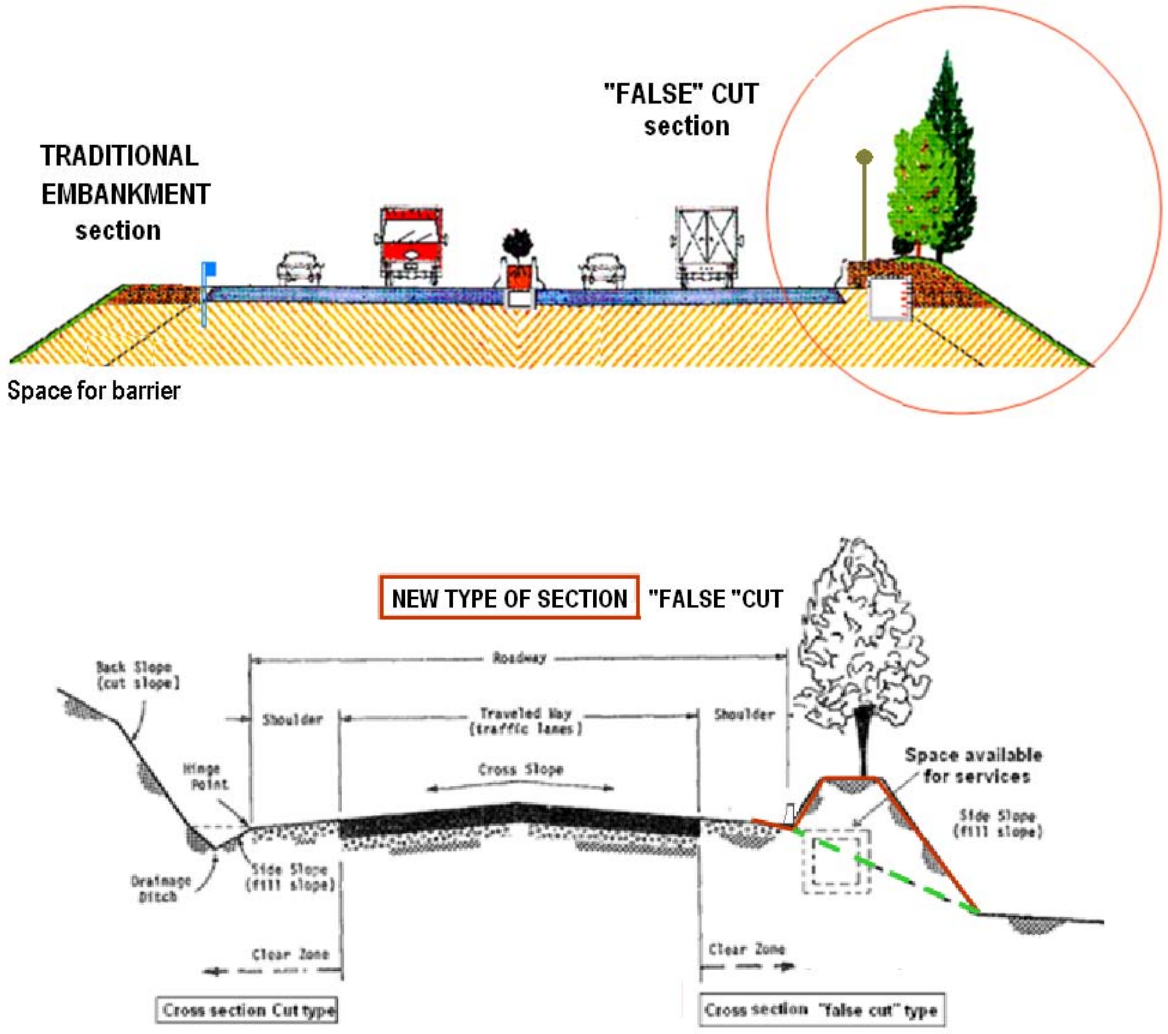


Figure 5.3: ***Examples of false cutting***

5.4 *Shape and slope of embankment slides*

An embankment is a man-made ridge of earth or stone that carries a road or railway. The term comprises all kinds of sloping roadsides including cut and fill slopes. A cut slope is the face of an excavated bank required to lower the natural ground line to the desired road profile. In contrast to that, a fill slope is the face of an embankment required to raise the desired road profile above the natural ground line. How hazardous a slope is depends on its height, its steepness and it's distance to the roadway edge.

5.5 *Unpaved shoulder*

Shoulder is the part of the roadway between the carriageway and the ditch or the (cutting or embankment) slope, which gives the carriageway lateral support.
If it's unpaved means it contains very little or no paved surface immediately beyond the edge line.

Figure 5.4: ***Example unpaved shoulder***

5.6 *New developments and future systems to European Countries*

Below replies, opinions and suggestions provided by Road Authorities of European Countries about innovative solutions for roadsides safety.

Austria

Austrian Road Authority is satisfied with present treatments for roadside hazards and it doesn't think new safety principles are necessary to improve the situation.
Concerning effectiveness of interventions they agree that it should be estimated according to casualty numbers and severity of injury. At present their evaluation method consists in detailed analysis of run-off accidents considering fatalities and injury accidents including detailed accident data.
Regarding new solutions, they know breakaway poles and they think their use is not necessary on motorway network but might work on rural roads with lower speeds.
They don't use and wouldn't use unpaved shoulder.
Solution of false cutting is used but not often, also implemented with draining water system and noise barrier. False cutting with air cleaning system instead is not used.
In combining guard rail with noise barrier they use both solution with concrete guard rail and solution with steel guard rail, depending on cases.
They know and use shoulder rumble strips, explaining their cost/benefit rate is good and highlighting that about 50% of fatalities comes from run-off accidents on motorways.
In addition to new roadside interventions they suggest crash cushions.
In their opinion the most used system in the future will be steel and concrete guard rails depending on the local situation.

Belgium – Walloon Region

Belgian Road Authority is satisfied with present treatments for roadside hazards, but thinks they would be improved adopting new safety principles.
Concerning effectiveness of interventions they agree that it should be estimated according to casualty numbers and severity of injury.
Regarding new solutions, they don't know breakaway poles but they would use this solution on their roads.
They know that changes in shape and slope of embankment slides can improve road safety.

They use both unpaved shoulder and false cutting, but this latest without draining water system, noise barrier and air cleaning system.
In combining guard rail with noise barrier they use both solution with concrete guard rail and solution with steel guard rail, depending on cases.
They know and use shoulder rumble strips explaining this solution help and assist the driver.
Their favorite solution is noisy painted sign and this will be also, in their opinion, the most used system in the future, especially on motorways.

Finland

Finnish Authority comments on present situation concerning roadside hazards, explaining that safe side ditch designs have been developed; lighting columns are passively safe in 100% of new installations, since year 1997, and existing columns have been modified to passively safe; vertical signs since year 2000.
They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury.

Concerning new solutions, they know and use breakaway poles like passively safe vertical sign supports and passively safe lighting columns, systems described in publications by Finnish Road Administration “Vertical sign support with passive safety, year 2005” and ht “Break-away lighting columns, current practice in Finland in 1998”.
They consider changes in shape and slope of embankment slides improving for road safety.
They don’t use either unpaved shoulder or false cutting. In particular they wouldn’t use false cutting because it prevents snow removal.
In combining guard rail with noise barrier they use both solution with concrete guard rail and solution with steel guard rail, depending on cases.
Rumble strips are used.
They suggest safe ditch like innovative solution, as described in publication “Safety of roadside area. Analysis of full-scale crash tests and simulations”, which is a final report of the analyses of both simulations conducted during the project and full-scale tests of side ditches performed in Finland and Sweden during years 2000-2001. Main objective of this analysis was to evaluate the safety of different roadside profiles, which were defined by the management group of the project. The analyses are based on data from simulations and full-scale tests.

Lithuania

Lithuanian Road Authority is pleased with present treatments for roadside hazards but thinks new safety principles are needed to improve the situation, for example making a change of current standards to new, a change of strength class for barriers and a change of using rules; removing obstacles from roadsides.
They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury. They don’t have an evaluation methodology at present.
They know and use breakaway poles on Lithuanian roads as roadside markings.
They consider changes in shape and slope of embankment slides improving for road safety.
They currently don’t use unpaved shoulder but they would use it for one of the most potentially dangerous driving maneuvers, the overtake.
They don’t use false cutting and they are not willing to use this solution because, in their opinion, is too expensive.
In combining guard rail with noise barrier they choose solution with steel guard rail.
They use rumble strips because it’s a suitable solution to attract attention and to avoid driving

on roadsides.
Among different solutions, they prefer using steel guard rails because they prevent truck collisions, protecting people, property and equipment from harm. In the future the most common systems will be steel guardrails, rumble strips, vertical and horizontal markings but also roadsides with no obstacles.

Poland

Polish Road Authority is satisfied with present treatments for roadside hazards and it doesn't think new safety principles are necessary to improve the situation.
They know and use breakaway poles on Polish roads. They consider changes in shape and slope of embankment slides improving for road safety.
They don't use unpaved shoulder but they are willing to use this solution on their network.
They don't use false cutting and they are not willing to use it.
In combining guard rail with noise barrier they choose solution with steel guard rail.
Rumble strips are used on Polish road network.

Slovenia

Slovenian Road Authority isn't satisfied with present treatments for roadside hazards and thinks new safety principles are needed to improve the situation. In their opinion, first there must be a general understanding and implementation of human factor concept into the road design. So that road would be built maintained in that vision in mind.
They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury. Their comment is that every intervention has its effect on people, by considering the human factor (perception…) as well the impact factor on human body when accident happens. The intervention should be as human friendly as possible.
They know breakaway poles but they wouldn't use this solution on their roads because it is included in proposition for modification of Technical specifications.
They consider changes in shape and slope of embankment slides improving for road safety.
They don't use unpaved shoulder but they are willing to use this solution on their network.
There is enough space to correct the driver mistake and also too wide roads can be narrowed (speed management).
They don't make use of false cuttings.
In combining guard rail with noise barrier they use both solution with concrete guard rail and solution with steel guard rail, depending on cases.
Rumble strips are used to alert drivers when crossing the edge or center line.
Future solutions aim to self explanatory and forgiving roadside, so the driver could foreseen what lies ahead and if he/she should make a mistake it could be corrected.

Malta

Malta Road Authority is not satisfied with present treatments for roadside.
About new solutions, they know breakaway poles but they wouldn't use on their roads because in most of the cases, locally there are other activities happening on the roads other than motorists. Breakaway poles can pose a hazard to other road users.
They consider changes in shape and slope of embankment slides improving for road safety.
They don't use unpaved shoulder mostly due to the limit of space on the roadsides, but they are willing to use this solution on their network.
They don't use false cutting due to the limit of space; its use has to be justified by a sound business case since implementing it might mean considerable expenses in expropriating surrounding areas of land. The false cutting also can pose an issue with available space

during reconstruction of existing roads.
Presently they are not using noise barriers.
Rumble strips are used on Malta roads because this solution enhances road safety without taking up a lot of space, it's efficient to implement and is effective.
They, however, prefer using steel barriers due to:

- easy assembly;
- flexibility and versatility;
- aesthetics when compared to concrete solutions.

Future solutions are related to the exploitation of steel in enhancing road safety systems.

Ireland

Irish Road Authority isn't satisfied with present treatments for roadside hazards and thinks new safety principles are needed to improve the present situation.
They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury; they measure reduction is collision numbers, as well as

factoring in collision costs based on 'Willingness To Pay' principle.
They know frangible devices like breakaway poles, lattix posts, breakaway lighting columns and they have used lattix posts in the past, but, due to their high cost, they are now using a framework of tubular steel which gives the same effect at much reduced cost.
They consider changes in shape and slope of embankment slides improving for road safety.
They don't use unpaved shoulder but they would use it as it gives the driver an extra safety factor in cases of driver error.
They usually don't use false cuttings; they have used them in situations where there is a difference in level between different sides of a motorway or dual carriageway, but this is the only use they make of them.
They are aware of shoulder rumble strips and they use them on both medians of their motorways, as well as the roadside edges, as they alert the drivers that they are wandering off the roadway.
A new measure they are using more and more is Vehicle Activated Signs with associated warning signals to alert drivers to sharp bends ahead or other hazards.
They are also developing a vehicle activated system to warn Ghost drivers (wrong way drivers) where they are entering the motorway in the wrong direction.
For future use, more and more ITS type developments will come on stream that they expect to be of benefit in the road safety area.

Sweden

Swedish Road Authority isn't satisfied with present treatments for roadside hazards and thinks new safety principles are needed, especially in regard to terminations and intersection/access designs.
They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury.
They know frangible devices like breakaway poles, lattix posts, breakaway lighting columns; they only use breakaway poles on new installations since 30 years.
Their experience challenge the idea of wide safety zones with smooth slopes. Their experience is that barriers are superior from a safety viewpoint. Verges are not used in Sweden but they have support shoulders which are not paved on most high speed roads.
False cutting is used on motorway medians and in roadside areas in very special situations.
Rumble strips are normally used on motorways. Single carriageway roads normally have a centre rumble strip instead.

They think barriers offer the best potential for future use and safety benefits.

Estonia

Estonian Road Authority is satisfied with present treatments for roadside hazards but thinks new safety principles are needed to improve the situation. In particular they would use more safety zones.
They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury; they evaluate this by comparison of roads with and without interventions.
They know frangible devices like breakaway poles, lattix posts, breakaway lighting columns and they think on certain situations they need to be used for safety reasons and because other solutions cannot be used (i.e. in narrow conditions where there is not enough space).
They consider changes in shape and slope of embankment slides improving for road safety.
They use unpaved shoulder but don't use false cutting because they don't see the need for it.
They are aware of shoulder rumble strips but they don't use this solution because of the icing on wintertime.

They are aware of other measures:

- Shoulder rumble strips with elevated strips;
- "Drop-on-Line" marking, which is shoulder-marking with big drops of thermoplastic which form the edge-line of the road;
- Honeycomb shaped unpaved shoulder strengthening.

They appreciate "Drop-on-Line" marking, but generally they prefer using complex solutions according to the situation.
The best potential for future, in their opinion, is given by horizontal marking with rumble effect.

Iceland

Icelandic Road Authority isn't satisfied with present treatments for roadside hazards and thinks new safety principles are needed to improve the present situation. In particular, the solutions for motorcyclists are not good enough. Something has to be done to make it less dangerous for motorcyclists to collide with the pillars of safety barriers (steel guardrails and wire rope barriers).
They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury; they evaluate this by using before and after studies.
They know frangible devices like breakaway poles, lattix posts, breakaway lighting columns and they use them on their roads. According to the Icelandic Road Design Guidelines only poles that have been approved by IS-EN-12767 may be used within the safety zone. Serious accidents have happened when drivers have driven into old poles which were not approved by IS-EN-12767.
They are aware of improving road safety by changing shape and slope of embankment slides.
Unpaved shoulders are still in use on older roads. According to the Icelandic Road Design Guidelines, shoulders should be paved in general.
False cutting is not used.
They use rumble strips and the main purpose in Iceland is to make the driver alert if he is going to drive off the road or over to the lane for on-coming traffic. More than 60% of the rumble strips on Icelandic roads are used between driving directions. There is an interest in making more rumble strips but one of our problems is that they can only be "cut" into roads

with asphalt on but many of our roads are surface dressed and that kind of surface does not allow normal rumble strips.
The solution suggested is chevrons at sharp bends.
Their favorite system consists in variable message signs warning drivers when there suddenly is black-ice on the road surface. The Icelandic Road Administration operates automatic weather-stations at many spots so the data is already available.
For future use they believe that a safety zone of adequate width and road equipment which is approved by IS-EN_12767 together will give the most safety benefits.

France

French Road Authority is satisfied with present treatments for roadside hazards but thinks new safety principles are needed to improve the situation. They think that ITS could probably improve the situation.
They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury. They would better evaluate the effectiveness of barriers by

taking into account severity of injury and delineation with both casualty numbers and severity of injury.
They know frangible devices like breakaway poles, lattix posts, breakaway lighting columns and they experiment this equipment.
They are aware of improving road safety by changing shape and slope of embankment slides.
Unpaved shoulder is used but it depends on the road. Anyway it seems to be better to use a stabilized soil and to avoid grass for a better grip.
They don't use false cutting and they probably wouldn't use it because of investment and maintenance costs.
They experiment rumble strips.

The Netherlands

Dutch Road Authority isn't satisfied with present treatments for roadside hazards and thinks new safety principles are needed to improve the present situation. In particular, they create a detailed list of measures and the effectiveness of these measures. They agree effectiveness of interventions should be estimated according to casualty numbers and severity of injury.
They know frangible devices like breakaway poles, lattix posts, breakaway lighting columns and they use them on their roads.
They are aware of improving road safety by changing shape and slope of embankment slides.
Unpaved shoulder is used, false cutting not. They are aware of rumble strips but they don't use this type of intervention.

Germany

German Road Authority is satisfied with present treatments for roadside hazards but thinks new safety principles are needed to improve the present situation. Current measures are suitable for protecting hazardous roadsides. Instruments of infrastructure safety management help to identify locations where to apply these measures.
About estimation of effectiveness, road safety improvements have to fit the given accident situation, therefore an evaluation method is important. Currently such a method is being developed by bast and will be published as road safety handbook.
They know frangible devices like breakaway poles, lattix posts, breakaway lighting columns and they use them on their roads.

They are aware of improving road safety by changing shape and slope of embankment slides.
Unpaved shoulder solution is used. They are aware of rumble strips and they use this type of intervention. Pilot project with milled rumble strips of motorways showed promising results, more stretches are planned to be realized in 2011.
Usually, several potential safety measures are suitable for safety improvements. Some might be the correct choice for one situation but not suitable for the next situation. Improvements have to fit to the safety needs and the given local situation.
For future use and safety benefits, the best method consist in inducing calm driving and making roadside forgiving.

6 Conclusion and recommendations

Different versions of the questionnaire have been edited, gradually simplified, aiming to obtain relevant information to the issue of improving safety of the roadsides.
It's generally agreed that active safety involves all initiatives preventing accidents, as the run of road (ROR) of a vehicle, while passive safety involves all measures to reduce the consequences or effects from already occurred accidents.
The final version of the questionnaire was discussed and approved by CEDR board and this is the one sent to EU countries and reported in the present report.
Available data from questionnaire (16 European countries replied) compared and aggregated to identify similarities and differences, show a variable situation from one country to another, proving the common understanding that the roadsides need to be deeply improved.
The reason for variable understanding of importance of roadside could come from different legal approach which, in some countries, gives more responsibility to driver behave in comparison with others where driver or passenger must to be protected whatever dangerous is the behave. For this reason a better understanding of the influence of roadside on driving behaviour can help to find new solutions.

Table A

NEW SOLUTIONS APPRECIATED					
Solutions / Country	Breakaway devices	Rumble strips	False cutting	Shape and slope of embankment	Unpaved shoulder
Austria	X	X	X		
Belgium – Walloon Region	X	X	X	X	X
Estonia	X			X	X
Finland	X	X		X	
France	X	X		X	
Germany	X	X		X	X
Iceland	X	X		X	
Ireland	X	X		X	X
Italy	X	X	X	X	
Lithuania	X	X		X	X
Malta		X	X	X	X
Poland	X	X		X	X
Slovenia		X		X	X
Sweden	X	X			
The Netherlands	X			X	X

In fact, as example, roadsides on bridges represent the most critical situation in all countries (but they're well protected), while firstly embankments and secondly cuttings require a large improvement, which needs more research to transform and get better roadsides.
Type and size of safety barriers appeared to be less important: only their presence had an effect. Then concrete and steel barriers are most used solutions, but without attention to alternative possibilities, coming from new technologies as shown in the following tables.
Such tables, named table A for appreciation of new solutions, and table B for solutions used by the countries involved in the questionnaire, together confirm this traditional vision of roadsides.
Present used indicator does not help evolution of roadsides in the right direction of a better longitudinal homogeneity along different roadsides (such as embankment, cutting, tunnel bridge) and this can suggest new paths for future research.

Table B

SOLUTIONS USED					
Solutions / Country	Breakaway devices	Rumble strips	False cutting	Shape and slope of embankment	Unpaved shoulder
Austria	X	X	X		
Belgium – Walloon Region		X	X		X
Estonia	X				X
Finland	X	X			
France					X
Germany	X	X			X
Iceland	X	X			X
Ireland	X	X			
Italy	X	X	X		
Lithuania	X	X			
Malta		X			
Poland	X	X			
Slovenia		X			
Sweden	X	X	X		
The Netherlands	X				X

Apendix A

Questionnaire

QUESTIONNAIRE
ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided in three parts. The first part includes general questions about length of network and type of roadside implemented interventions. In the second part there are some questions to assess interventions mentioned in 1st part. The last part includes questions about new type of solutions to improve roadside safety.

1. General questions:

- Country: Austria
- Length of network:
  - Total network [km]: ~ 107000 km
  - Motorways [km]: 2130 km
  - Highways (single carriageway) [km]: 33880 km
  - Highways (dual carriageway) [km]:
  - Others [km]: 71000 km
- Saved with interventions on roadside (approximately):
  - Motorways [km]: road side: 2506 km, median: 1620 + 270 tunnels
  - Highways (single carriageway) [km]: n/a
  - Highways (dual carriageway) [km]: n/a
  - Others [km]: n/a
- Type of roadsides: choose a value between 1 and 5 to evaluate how often are saved (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☒	☐
Cutting	☐	☒	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☒
Tunnel roadside	☐	☒	☐	☐	☐

- Which of the following systems are used on your roadsides?

1. Concrete guard rails:

☒ yes ☐ no

- Please, specify if you use it in the following roadsides:

Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment (Fig.1)	☒	☐	☐	☐	☐
Cutting (Fig.2)	☐	☐	☐	☒	☐
Bridge roadside (Fig.3)	☒	☐	☐	☐	☐
Roadside with wall (Fig.4)	☐	☐	☐	☒	☐
Tunnel roadside (Fig.4)	☐	☐	☐	☒	☐

Fig.1

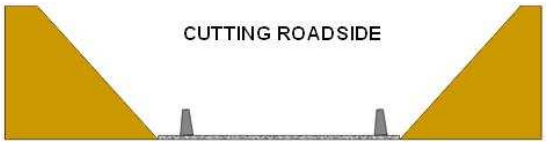


Fig.2

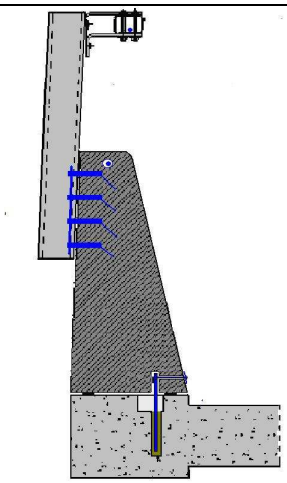


Fig.3

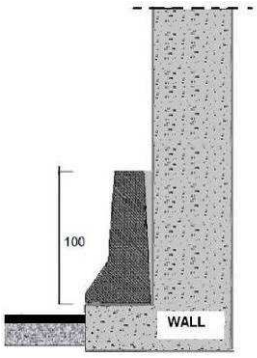


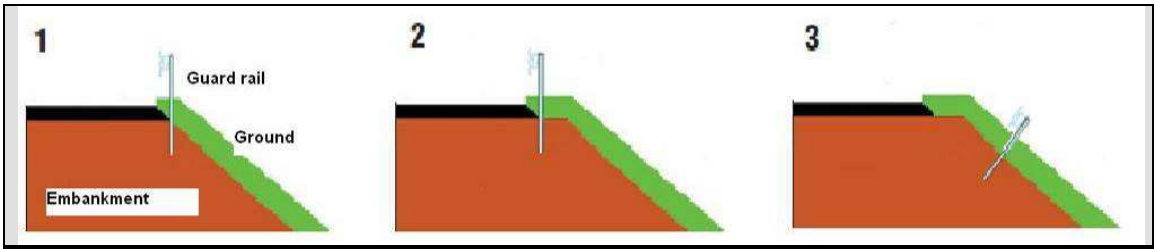
Fig.4

2. Steel guard rails:

☒ yes ☐ no

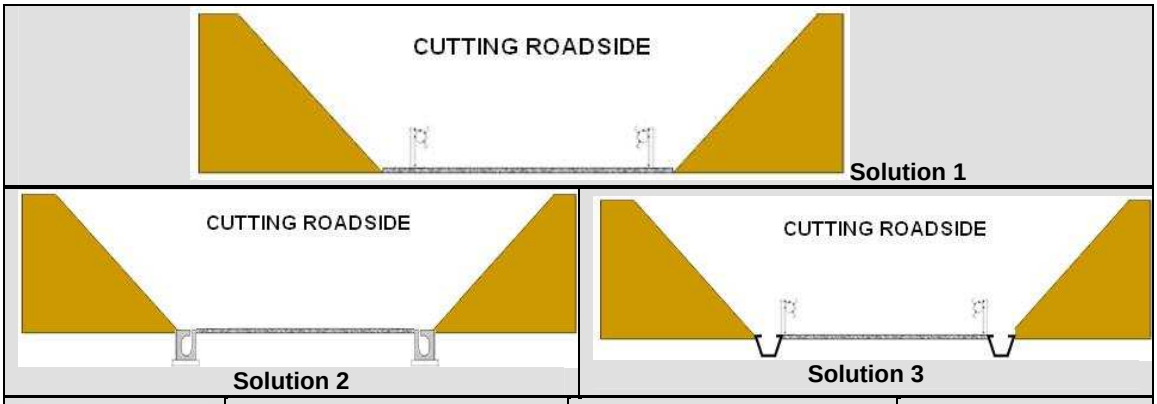
Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment	☒	☐	☐	☐	☐
Cutting	☐	☐	☐	☒	☐
Bridge roadside	☒	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☒	☐
Tunnel roadside	☐	☐	☐	☒	☐

- Embankment: looking at figure below, which kind of solution do you use?



	Solution 1	**Solution 2**	**Solution 3**
The most used	☐	☒	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☒	☐	☐
Not used	☐	☐	☒

- Cutting: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	☒	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☒	☐	☒
Not used	☐	☐	☐

3. Horizontal sign:

☒ yes ☐ no

- Do you always use horizontal sign on roadsides to highlight the edge? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☒
Cutting	☐	☐	☐	☐	☒
Bridge roadside	☐	☐	☐	☐	☒
Roadside with wall	☐	☐	☐	☐	☒
Tunnel roadside	☐	☐	☐	☐	☒

- Do you use horizontal sign like shown in Fig.5?

☒ yes ☐ no

- Please explain why yes/no:

Yes, in principal, but in Austria a lesser number of white stripes is used (less colour necessary), which leads to a more economic solution without compromising visibility.
……

	
Fig.5	Fig.6

4. Vertical sign:

☒ yes ☐ no

- Do you use vertical sign on roadsides to highlight edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☒
Cutting	☐	☐	☐	☐	☒
Bridge roadside	☐	☐	☐	☐	☒
Roadside with wall	☐	☐	☐	☐	☒
Tunnel roadside	☐	☐	☐	☐	☒

- Do you use vertical sign like example shown in Fig.6?

☒ yes ☐ no

- Please, explain why yes/no:

In principal yes, the signs are considered state-of-the-art in Austria but with different colours (red and white).

5. Fences:

- Do you use fences on bridge roadside like Fig.7?

☒ yes ☐ no

- Is it always combined with steel guard rail?

☒ yes ☐ no

- Please, explain if you use a different combination:

If a fence is used a guard rail (steel or concrete)is necessary in addition (fence and guardrail are not connected).

	
Fig.7	Fig.8

6. Walls:

- Do you use wall on roadside like Fig.8?

☒ yes ☐ no

- Choose a value between 1 and 5 to evaluate how often is used in following roadside (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☒	☐	☐	☐
Cutting	☒	☐	☐	☐	☐
Bridge roadside	☐	☒	☐	☐	☐

7. Other:

- Do you use other type of solution for roadside?

☐ yes ☒ no

Please, specify other system(s):

……

……

……

- Which other solution(s) do you use in tunnel?

……

……

- Which other solution(s) do you use on bridge?

……

……

- Which other solution(s) do you use in cutting?

……

……

- Which other solution(s) do you use on embankment?

……

……

- Which kind of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☒	☐	☐	☐
Steel guard rails	☒	☒	☒	☒
Horizontal sign	☒	☒	☒	☒
Vertical sign	☒	☒	☒	☒
Fences	☒	☒	☒	☒
Walls	☐	☐	☐	☒
Other	☐	☐	☐	☐

2. Assessment of implemented interventions

➢ How do you assess every intervention implemented in your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☐	☐	☒	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☐	☒	☐

Comments:
……

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☐	☐	☒	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☐	☒	☐

Comments:
……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☒	☐	☐	☐
Maintenance costs	☐	☐	☐	☒	☐
Easy to use (assembly and maintenance)	☐	☐	☒	☐	☐
Versatility	☒	☐	☐	☐	☐

Comments:
……

Vertical sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☒	☐	☐	☐
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☒
Versatility	☐	☐	☐	☐	☒

Comments:
……

Fences	1	2	3	4	5
Road safety	☐	☐	☒	☐	☐
Investment costs	☐	☐	☒	☐	☐
Maintenance costs	☐	☐	☒	☐	☐
Easy to use (assembly and maintenance)	☐	☒	☐	☐	☐
Versatility	☐	☒	☐	☐	☐

Comments: safety effect is quite high for bridges where people might drop things on the underlying road or rail

Walls	1	2	3	4	5
Road safety	☐	☒	☐	☐	☐
Investment costs	☐	☐	☐	☐	☒
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☒	☐	☐	☐	☐
Versatility	☒	☐	☐	☐	☐

Comments:
……

Other (specify)	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:
……

- How do you estimate safety performance? Do you use data of accidents?

  ☒ yes ☐ no

- Do you use an accident rate?

  ☒ yes ☐ no

- Which kind of rate is it? ☐ mortality rate
  ☐ injury rate
  ☒ global rate = mortality + injury

Please, explain your evaluation method: detailed analysis of run-off accidents considering fatalities and injury accidents including detailed accident data

……

- Results on safety performance are available for each type of roadside intervention?
  ☐ yes ☒ no

3. New developments and future systems

- Are you pleased with present solutions for roadside?
  ☒ yes ☐ no
- Do you think it would be implemented according to new safety principles?
  ☐ yes ☒ no

If yes, please explain how you improved/would improve this:

……
……
……

- Do you agree effectiveness of interventions should be estimate with damages to people?
  ☒ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

see above

……
……
……

- Do you know breakaway poles?
  ☒ yes ☐ no
- Do/Would you use them on your roads?
  ☒ yes ☒ no

Please, explain why yes/no:

no need for use on motorway network, but might work on rural roads with lower speeds.

……

- Do you know shape and slope of escarpment can improve road safety?
  ☐ yes ☐ no ??
- Do you use solution in Fig. 9?
  ☐ yes ☒ no
- If no, would you use it?
  ☐ yes ☒ no

Please, explain why yes/no:

……

……

……

Fig.9

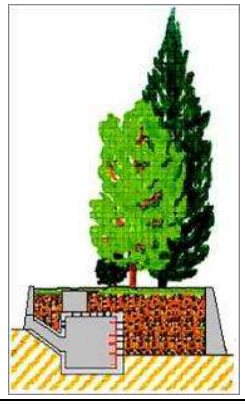


Fig.10

- Do you use solution in Fig.10 (false cutting)?

☒ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

solution is used but not often

……

……

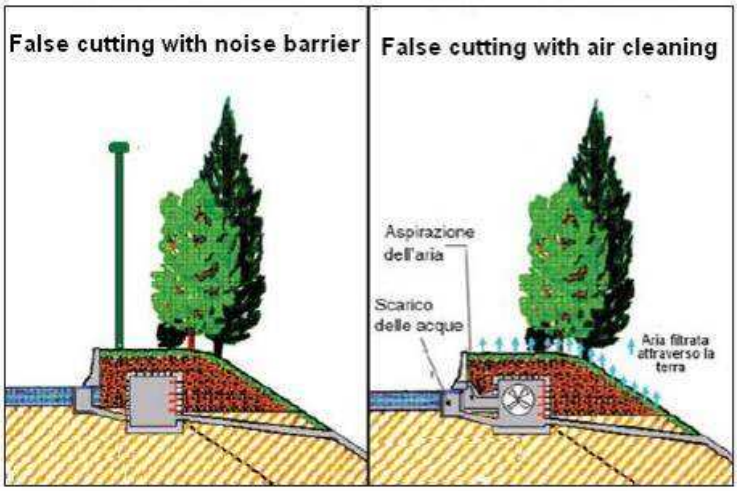


Fig.11

- Do you use solution in Fig.11 to drain water?

☒ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

Yes, but not often

……

……

- Do/Would you use false cutting with noise barrier (Fig.11)?

☒ yes ☐ no

Please explain why yes/no:

Yes, but not often

……

……

- Do/Would you use solution in Fig.11 to clean air?

☐ yes ☒ no

Please explain why yes/no:

……

……

……

- When you combine guard rail with noise barrier, which solution do you use?

☐ Solution with concrete guard rail (Fig.12)

☐ Solution with steel guard rail (Fig.13)

☒ Both, it depends on cases

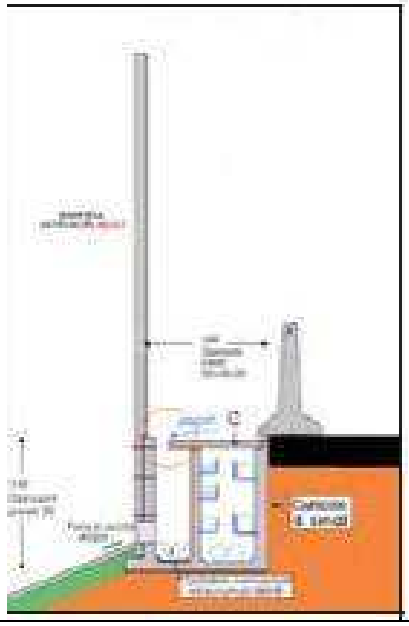


Fig.12

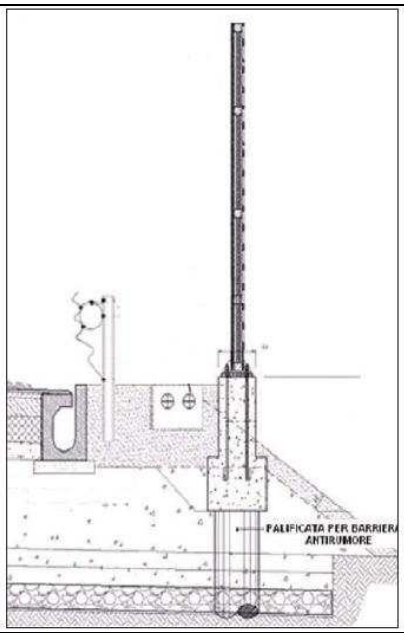


Fig.13

- Do you know rumble strips on road verge?

☒ yes ☐ no

- Do/Would you use this type of intervention?

☒ yes ☐ no

Please, explain why yes/no:

cost-benefit high, about 50 % of fatalities are run-off accidents on motorways

……

……

- Which other new roadside intervention do you know? Please, give a short description.

crash cushions

……

……

……

- Which system(s) would you prefer using and why?

……

……

……

- Which system(s), in your opinion, will be the most used in the future and why?

steel and concrete depending on the local situation

……

……

Thanks for answering our questionnaire. If you wish, we will provide you final results of our survey.

QUESTIONNAIRE
ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided in three parts. The first part includes general questions about length of network and type of roadside implemented interventions. In the second part there are some questions to assess interventions mentioned in 1st part. The last part includes questions about new type of solutions to improve roadside safety.

1. General questions:

- Country: BELGIUM
- Length of network: Wallon region
  - Total network [km]:
  - Motorways [km]: 874
  - Highways (single carriageway) [km]:
  - Highways (dual carriageway) [km]: 6850
  - Others [km]:
- Saved with interventions on roadside (approximately):
  - Motorways [km]: ± 200
  - Highways (single carriageway) [km]:
  - Highways (dual carriageway) [km]: ± 2000
  - Others [km]:
- Type of roadsides: choose a value between 1 and 5 to evaluate how often are saved (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☒	☐	☐
Cutting	☐	☐	☒	☐	☐
Bridge roadside	☐	☐	☐	☐	☒
Tunnel roadside	☐	☐	☐	☐	☒

- Which of the following systems are used on your roadsides?

1. Concrete guard rails:

☒ yes ☐ no

- Please, specify if you use it in the following roadsides:

Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment (Fig.1)	☐	☐	☐	☒	☐
Cutting (Fig.2)	☐	☐	☐	☐	☒
Bridge roadside (Fig.3)	☐	☐	☐	☒	☐
Roadside with wall (Fig.4)	☐	☐	☐	☒	☐
Tunnel roadside (Fig.4)	☐	☐	☐	☒	☐

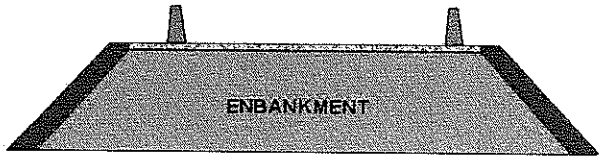


Fig.1

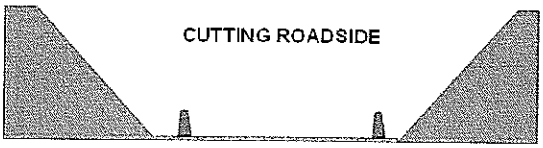


Fig.2

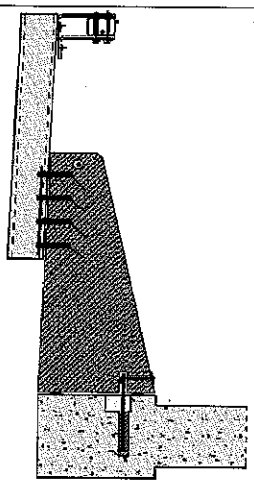


Fig.3

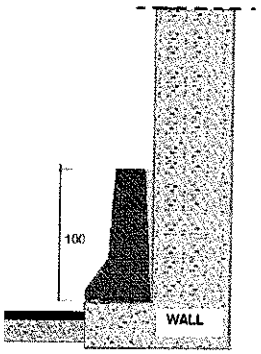


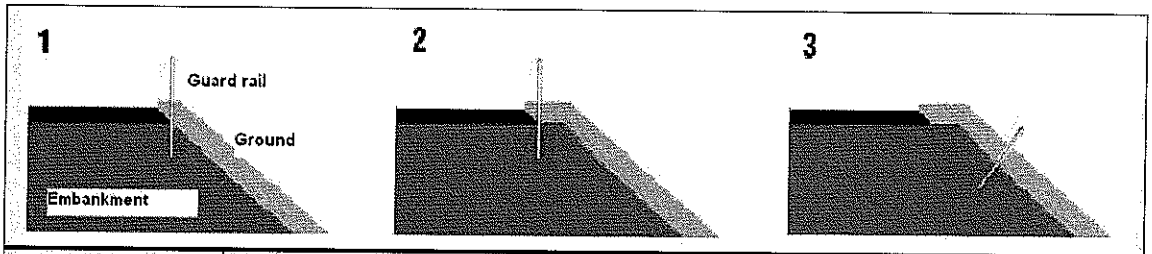
Fig.4

2. Steel guard rails:

☐ yes ☐ no

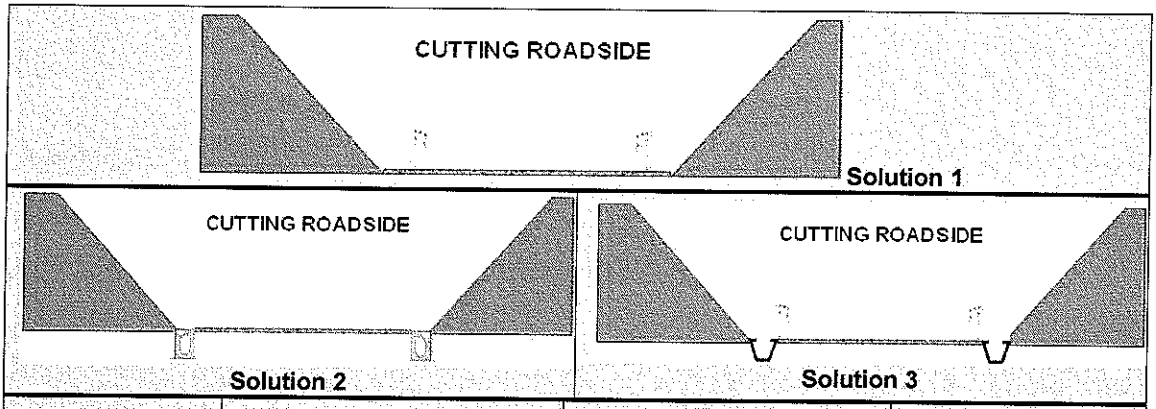
Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment	☒	☐	☐	☐	☐
Cutting	☐	☐	☐	☒	☐
Bridge roadside	☒	☐	☐	☐	☐
Roadside with wall	☒	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☒	☐

- Embankment: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	☒	☐
The least used	☒	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	☐
Not used	☐	☐	☒

- Cutting: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	☒	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☒	☐	☒
Not used	☐	☐	☐

3. Horizontal sign:

☒ yes ☐ no

- Do you always use horizontal sign on roadsides to highlight the edge? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☒	☐	☒	☐
Cutting	☐	☒	☐	☒	☐
Bridge roadside	☐	☒	☐	☒	☐
Roadside with wall	☐	☒	☐	☒	☐
Tunnel roadside	☐	☒	☐	☒	☐

- Do you use horizontal sign like shown in Fig.5?

☒ yes ☐ no

- Please explain why yes/no:

security

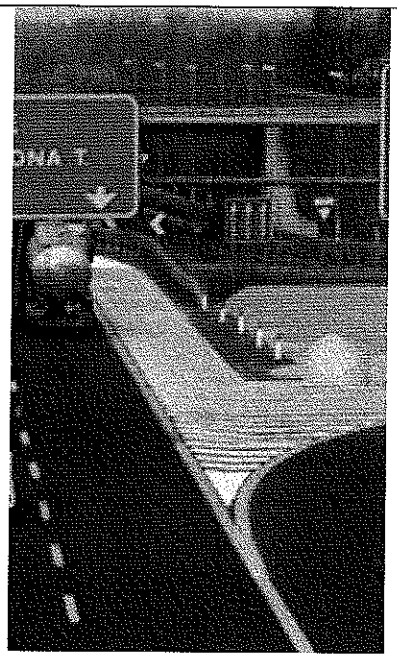


Fig.5

Fig.6

4. Vertical sign:

☒ yes ☐ no

- Do you use vertical sign on roadsides to highlight edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☒	☐	☐
Cutting	☐	☒	☐	☐	☐
Bridge roadside	☐	☐	☒	☐	☐
Roadside with wall	☐	☐	☒	☐	☐
Tunnel roadside	☐	☐	☒	☐	☐

- Do you use vertical sign like example shown in Fig.6?

☐ yes ☒ no

- Please, explain why yes/no:

danger.

5. Fences:

- Do you use fences on bridge roadside like Fig.7?

☐ yes ☒ no

- Is it always combined with steel guard rail?

☒ yes ☐ no

- Please, explain if you use a different combination:

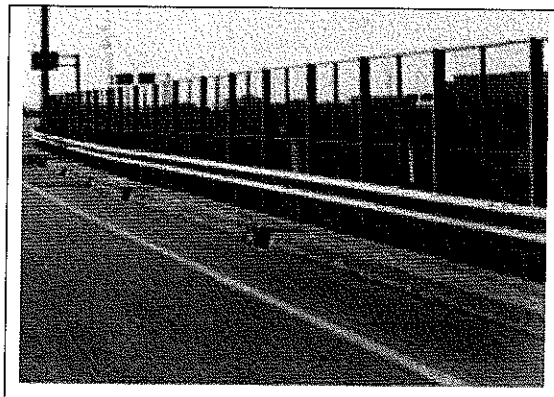


Fig.7

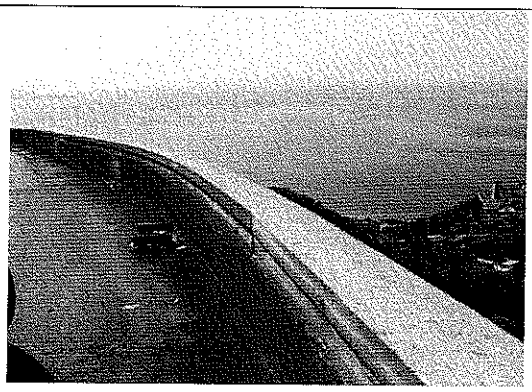


Fig.8

6. Walls:

- Do you use wall on roadside like Fig.8?

☐ yes ☒ no

- Choose a value between 1 and 5 to evaluate how often is used in following roadside (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐

7. Other:

- Do you use other type of solution for roadside?

☒ yes ☐ no

Please, specify other system(s):

Steel guard rails or Concrete guard rails

- Which other solution(s) do you use in tunnel?

none.

- Which other solution(s) do you use on bridge?

none.

- Which other solution(s) do you use in cutting?

the same

- Which other solution(s) do you use on embankment?

the same

- Which kind of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	Central ☒	☐	☐	☐
Steel guard rails	Lateral ☒	☒	☒	☒
Horizontal sign	☒	☒	☒	☐
Vertical sign	☒	☒	☒	☐
Fences	☐	☐	☐	☐
Walls	☐	☐	☐	☐
Other	☐	☐	☐	☐

2. Assessment of implemented interventions

➢ How do you assess every intervention implemented in your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☒	☐	☐	☐	☒
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☒	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Vertical sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Fences	1	2	3	4	5
Road safety	☒	☐	☐	☐	☐
Investment costs	☒	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Walls	1	2	3	4	5
Road safety	☒	☐	☐	☐	☐
Investment costs	☒	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Other (specify)	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

- How do you estimate safety performance? Do you use data of accidents?

  ☒ yes ☐ no

- Do you use an accident rate?

  ☒ yes ☐ no

- Which kind of rate is it? ☒ mortality rate
  ☐ injury rate
  ☐ global rate

Please, explain your evaluation method:

Statistics

- Results on safety performance are available for each type of roadside intervention?
  ☒ yes ☐ no

3. New developments and future systems

- Are you pleased with present solutions for roadside?
  ☒ yes ☐ no
- Do you think it would be implemented according to new safety principles?
  ☒ yes ☐ no

If yes, please explain how you improved/would improve this:

- Do you agree effectiveness of interventions should be estimate with damages to people?
  ☒ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

- Do you know breakaway poles?
  ☐ yes ☒ no
- Do/Would you use them on your roads?
  ☒ yes ☐ no

Please, explain why yes/no:

- Do you know shape and slope of escarpment can improve road safety?
  ☒ yes ☐ no
- Do you use solution in Fig. 9?
  ☒ yes ☐ no
- If no, would you use it?
  ☐ yes ☐ no

Please, explain why yes/no:

.....

.....

.....

Fig.9

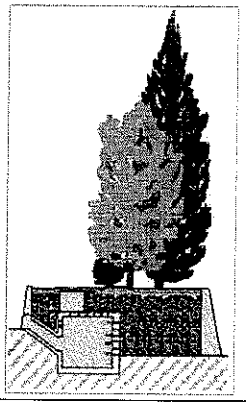


Fig.10

- Do you use solution in Fig.10 (false cutting)?

☒ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

.....

.....

.....

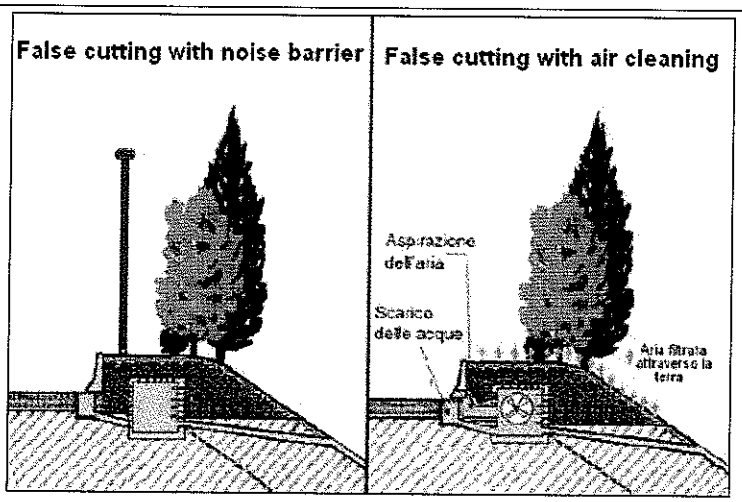


Fig.11

- Do you use solution in Fig.11 to drain water?

☐ yes ☒ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

.....

.....

.....

- Do/Would you use false cutting with noise barrier (Fig.11)?

☐ yes ☒ no

Please explain why yes/no:

.....

.....

.....

- Do/Would you use solution in Fig.11 to clean air?

☐ yes ☒ no

Please explain why yes/no:

.....

.....

.....

- When you combine guard rail with noise barrier, which solution do you use?

☐ Solution with concrete guard rail (Fig.12)

☐ Solution with steel guard rail (Fig.13)

☒ Both, it depends on cases

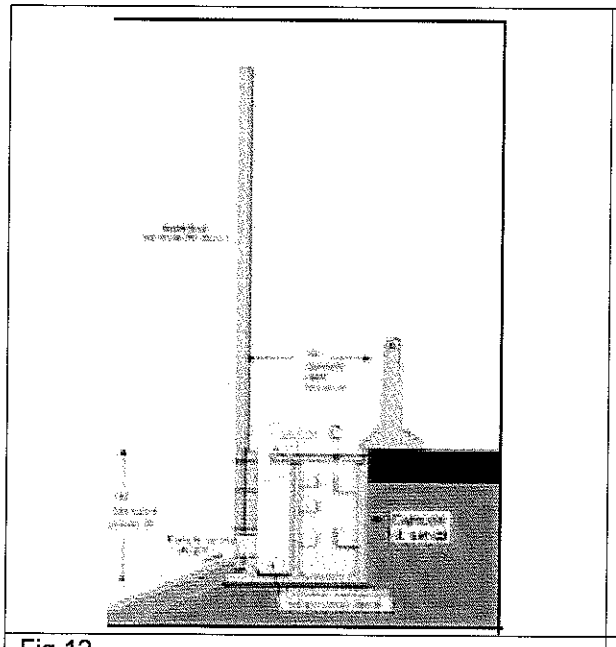


Fig.12

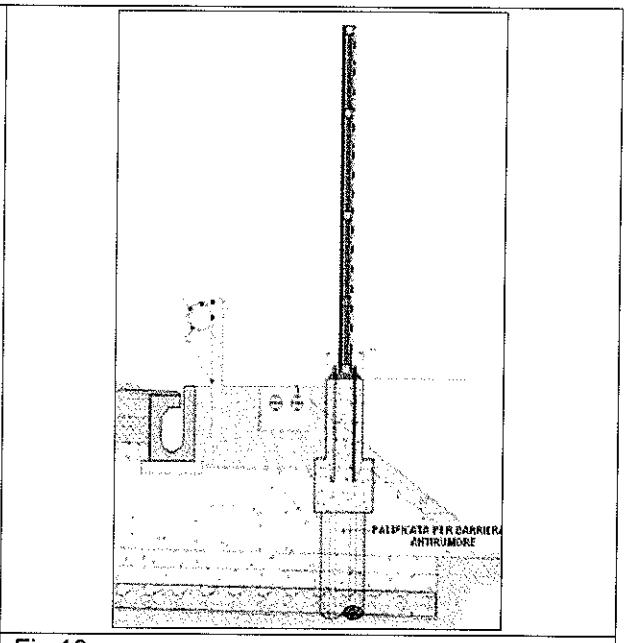


Fig.13

- Do you know rumble strips on road verge?

☒ yes ☐ no

- Do/Would you use this type of intervention?

☒ yes ☐ no

Please, explain why yes/no:

help and assist the driver

- Which other new roadside intervention do you know? Please, give a short description.

only not noisy painting signs

- Which system(s) would you prefer using and why?

noisy painting signs

- Which system(s), in your opinion, will be the most used in the future and why?

noisy painting signs (on motorway specially)

Thanks for answering our questionnaire. If you wish, we will provide you final results of our survey.

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- How you assess interventions
- New solutions for roadsides

1. General questions:

- Country ESTONIA
- Length of rural network for which the National Road Authority is responsible:

Total network [km]:	16 500
Motorways [km]:	-
Highways (dual carriageway) [km]:	115
Highways (single carriageway) [km]:	16 319
Others [km]:	66

2. Roadside treatments:

- Roadsides protected with safety barriers (approximately):

Motorways [%]:	-
Highways (dual carriageway) [%]:	40%
Highways (single carriageway) [%]:	1%
Others [%]:	13%

- Type of roadsides: choose a value between 1 and 5 to evaluate how often they are protected with safety barriers (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☒	☐	☐	☐
Cutting	☒	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☒
Tunnel roadside	☐	☐	☐	☒	☐

Please return completed questionnaires to: francesca.latorre@unifi.it

1. **Slopes:**

- Do you consider the slope of the embankment as a factor to identify the potential safety hazard of the roadside element?

☒ yes ☐ no

- Which is the reference standard/procedure for calculation?

Norms and requirements of road design:
https://www.riigiteataja.ee/aktilisa/0000/0076/3437/TSM_m_55_.pdf

2. **Safety zone:**

- Do you define a safety zone outside of which hazards do not need to be protected/delineated?

☒ yes ☐ no

- Which is the reference standard/procedure for calculation?

Norms and requirements of road design:
https://www.riigiteataja.ee/aktilisa/0000/0076/3437/TSM_m_55_.pdf

- Do you consider shoulders as part of the safety zone?

☒ yes ☐ no

- If you use safety zone, what criteria do you use to choose between safety zone or safety barrier?

We use safety barrier if there is irremovable obstacle within safety zone.

3. **Horizontal signs (markings):**

- Do you use special horizontal markings (e.g. rumble strips) on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☒	☐	☐	☐
Cutting	☐	☒	☐	☐	☐
Bridge roadside	☐	☒	☐	☐	☐
Roadside with wall	☐	☒	☐	☐	☐
Tunnel roadside	☐	☒	☐	☐	☐

4. Vertical signs:

- Do you use roadside delineation to highlight the road edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☒	☐
Cutting	☐	☐	☐	☒	☐
Bridge roadside	☐	☐	☐	☐	☒
Roadside with wall	☐	☐	☐	☒	☐
Tunnel roadside	☐	☐	☐	☒	☐

5. Other:

- Do you use other types of solution for protecting obstacles or delineating the roadside where there are hazards?

☐ yes ☒ no

Please, specify other system(s):

……
……
……

- Which other solution(s) do you use in tunnels?

……
……

- Which other solution(s) do you use on bridges?

……
……

- Which other solution(s) do you use for cuttings?

……
……

- Which other solution(s) do you use on embankments?

……
……

- Which type of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	☐	☒	☒	☒
Wire rope barriers	☐	☒	☒	☒
Horizontal sign	☐	☒	☒	☐
Delineation	☐	☒	☒	☒
Other (specify)	☐	☐	☐	☐

3. Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

We don’t have concrete guard rails.

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☒	☐	☐
Versatility	☐	☐	☐	☒	☐

Comments:

It is the most used type of roadside intervention in Estonia.

Wire rope barriers	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☐	☒	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☒	☐	☐
Versatility	☐	☐	☐	☒	☐

Comments:

Seldom used in certain places.

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☒	☐	☐
Investment costs	☐	☒	☐	☐	☐
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☐	☒	☐

Comments:

Usage is growing year by year.

Delineation	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☒	☐	☐
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☐	☒	☐

Comments:

We use it on all roads if AADT is higher than certain number.

Other (specify)……..	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

……

- How do you assess safety performance? Do you use accident data?

  ☒ yes ☐ no

- Do you use an accident rate per traffic flow (e.g. per billion vehicle x km)?

  ☒ yes ☐ no

- If yes, Which kind of rate is it? ☒ mortality rate (fatalities)

  ☒ injury rate (injured casualties)

  ☐ global rate

Please explain your evaluation method:

……

……

……

- Are results on safety performance available for each type of roadside intervention?

  ☐ yes ☒ no

4. New developments and future systems

- Are you satisfied with present treatments for roadside hazards?

☒ yes ☐ no

- Do you think that adopting new safety principles would improve the situation?

☒ yes ☐ no

If yes, please explain how you improved/would improve this:

We would use more safety zones.

……
……
……

- Do you agree that the effectiveness of interventions should be estimated according to casualty numbers and severity of injury?

☒ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

By comparison of roads with and without interventions.

……
……
……

- Do you know of breakaway poles/lattix posts/breakaway lighting columns or other frangible devices?

☒ yes ☐ no

- Do/Would you use them on your roads?

☒ yes ☐ no

Please, explain why yes/no:

On certain situations they need to be used for safety reasons and because other solutions cannot be used (ie in narrow conditions where there is not enough space).

- Do you know that a change in the shape and slope of embankment slides can improve road safety?

☒ yes ☐ no

- Do you use an unpaved shoulder (see Fig. 9)?

☒ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

……

……

……

Fig.9

- Do you use false cutting (see Fig.10)?

☐ yes ☒ no

- If no, would you use it?

☐ yes ☒ no

Please, explain why yes/no:

We don't see the need for it.

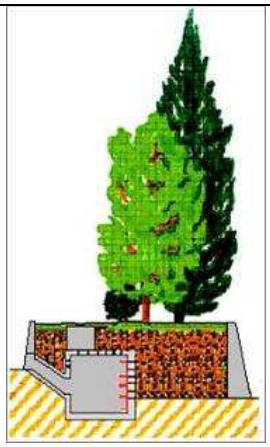


Fig.10

- Are you aware of shoulder rumble strips (see Fig. 14)?

☒ yes ☐ no

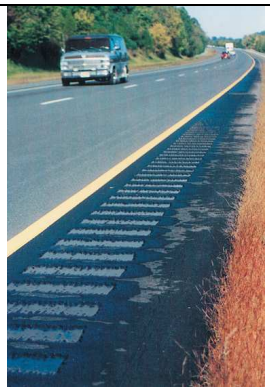


Fig.14

- Do/Would you use this type of intervention?

☐ yes ☒ no

Please, explain why yes/no and give a description of the type of shoulder rumble strip measure used:

Because of the icing on wintertime.

- Please give a short description of any other measure you are aware of.

Shoulder rumble strips with elevated strips (contrariwise as Fig. 14).

“Drop-on-Line” marking which is shoulder-marking with big drops of thermoplastic which form the edge-line of the road.

Honeycomb shaped unpaved shoulder strengthening.

- Which system(s) (measure) would you prefer to use and why?

“Drop-on-Line” marking, but generally we prefer to use complex solutions according to the situation.

- Which single system (measure) do you think offers the best potential for future use and safety benefits?

Horizontal marking with rumble effect.

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided in three parts. The first part includes general questions about length of network and type of roadside implemented interventions. In the second part there are some questions to assess interventions mentioned in 1st part. The last part includes questions about new type of solutions to improve roadside safety.

1. General questions:

- Country: Finland
- Length of network:
  - Total network [km]: 80 000
  - Motorways [km]: 800
  - Highways (single carriageway) [km]: 9000
  - Highways (dual carriageway) [km]: 230
  - Others [km]: .....
- Saved with interventions on roadside (approximately):
  - Motorways [km]: 32 %
  - Highways (single carriageway) [km]: 6 %
  - Highways (dual carriageway) [km]: 32 %
  - Others [km]: ?
- Type of roadsides: choose a value between 1 and 5 to evaluate how often are saved (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	x☐	☐
Cutting	☐	☐	☐	x☐	☐
Bridge roadside	☐	x☐	☐	☐	☐
Tunnel roadside	☐	x☐	☐	☐	☐

- Which of the following systems are used on your roadsides?

1. Concrete guard rails:

x☐ yes ☐ no

- Please, specify if you use it in the following roadsides:

Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment (Fig.1)	☐	☐	☐	x☐	☐
Cutting (Fig.2)	☐	☐	☐	☐	x☐
Bridge roadside (Fig.3)	☐	☐	☐	x☐	☐
Roadside with wall (Fig.4)	☐	☐	☐	☐	x☐
Tunnel roadside (Fig.4)	x☐	☐	☐	☐	☐

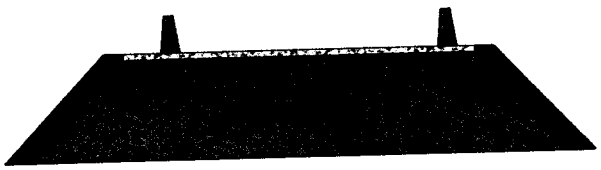


Fig.1

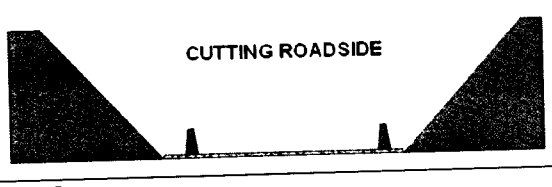


Fig.2

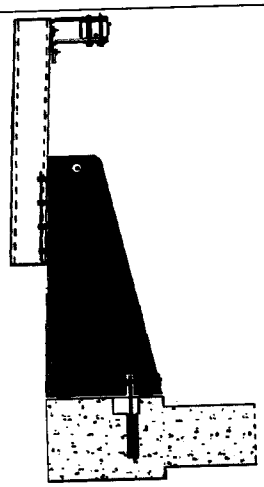


Fig.3

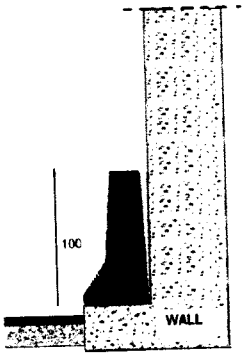


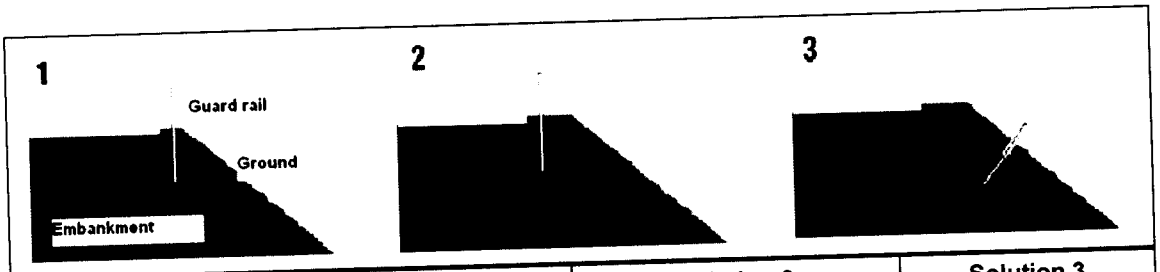
Fig.4

2. Steel guard rails:

x☐ yes ☐ no

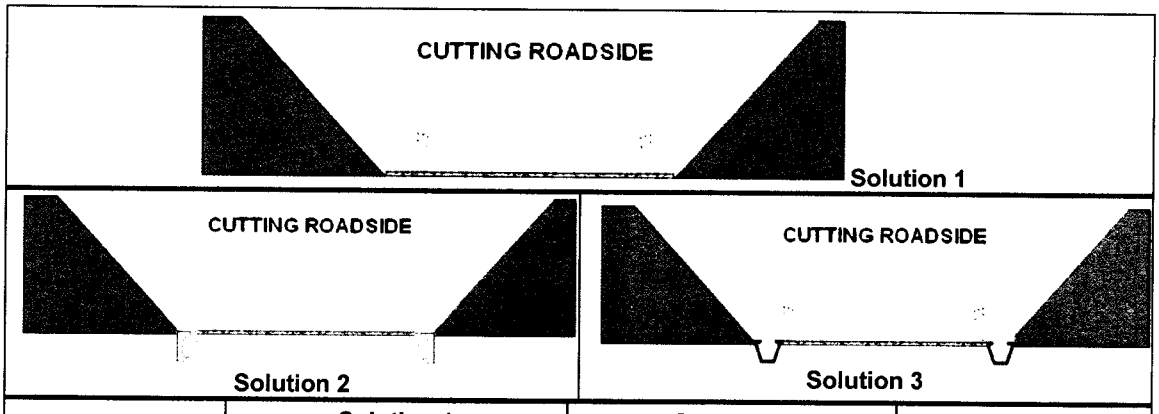
Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment	x☐	☐	☐	☐	☐
Cutting	x☐	☐	☐	☐	☐
Bridge roadside	x☐	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☐	x☐
Tunnel roadside	☐	☐	☐	☐	x☐

- Embankment: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	☐	x☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	x☐	☐	☐
Not used	☐	☐	x☐

- Cutting: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	x☐	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	☐
Not used	x☐	☐	x☐

3. Horizontal sign:

x☐ yes ☐ no

- Do you always use horizontal sign on roadsides to highlight the edge? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	x☐
Cutting	☐	☐	☐	☐	x☐
Bridge roadside	☐	☐	☐	☐	x☐
Roadside with wall	☐	☐	☐	☐	x☐
Tunnel roadside	☐	☐	☐	☐	x☐

- Do you use horizontal sign like shown in Fig.5?

☐ yes x☐ no

- Please explain why yes/no:

.....
.....
.....
.....

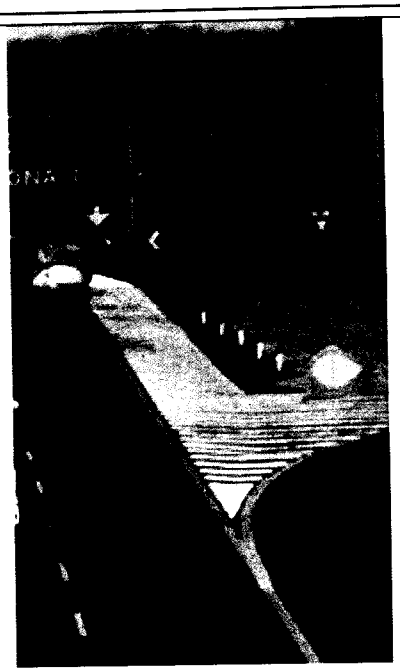


Fig.5

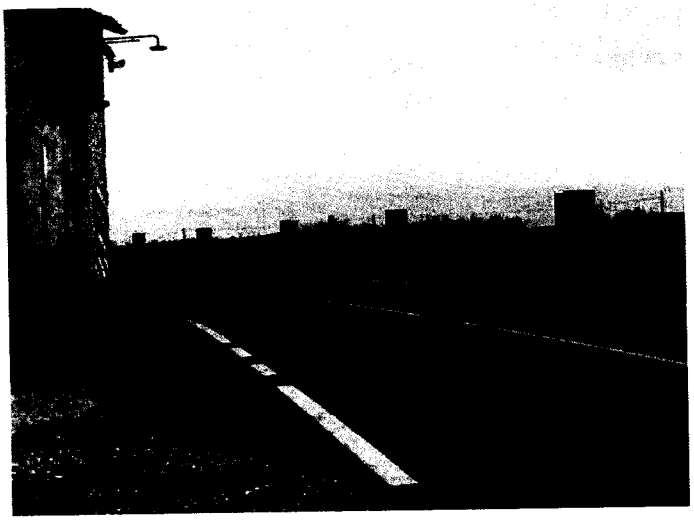


Fig.6

4. Vertical sign:

☐ yes x☐ no

- Do you use vertical sign on roadsides to highlight edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	☐

- Do you use vertical sign like example shown in Fig.6?

☐ yes x☐ no

- Please, explain why yes/no:

.....No sharp curves on main roads

5. Fences:

- Do you use fences on bridge roadside like Fig.7?

☐ yes ☐ no

- Is it always combined with steel guard rail?

☐ yes ☐ no

- Please, explain if you use a different combination: 1.2 m high parapet, H2

.....

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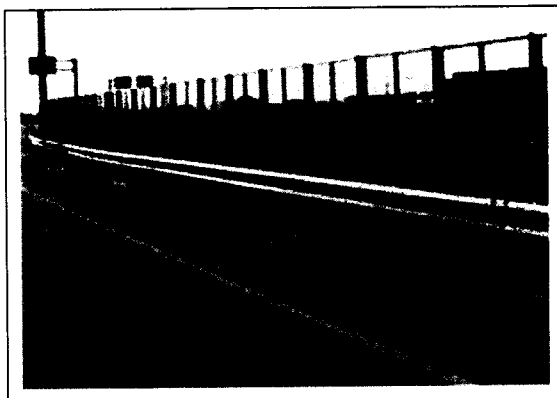

Fig.7

Fig.8

6. Walls:

- Do you use wall on roadside like Fig.8?

☐ yes x☐ no

- Choose a value between 1 and 5 to evaluate how often is used in following roadside (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐

7. Other:

- Do you use other type of solution for roadside?

☐ yes ☐ no

Please, specify other system(s):

.....

.....

.....

- Which other solution(s) do you use in tunnel?

.....

.....

- Which other solution(s) do you use on bridge?

.....

.....

- Which other solution(s) do you use in cutting?

.....

.....

- Which other solution(s) do you use on embankment?

1 to 4 slope

.....

.....

- Which kind of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	x☐	x☐	x☐	☐
Horizontal sign	x☐	x☐	x☐	☐
Vertical sign	☐	☐	☐	☐
Fences	☐	☐	☐	☐
Walls	☐	☐	☐	☐
Other	☐	☐	☐	☐

2. Assessment of implemented interventions

➢ How do you assess every intervention implemented in your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	x☐	☐
Investment costs	☐	☐	☐	x☐	☐
Maintenance costs	x☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	x☐	☐
Investment costs	☐	x☐	☐	☐	☐
Maintenance costs	☐	x☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	x☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	x☐	☐
Investment costs	x☐	☐	☐	☐	☐
Maintenance costs	x☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	x☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Vertical sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Fences	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Walls	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Other (specify)	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

- How do you estimate safety performance? Do you use data of accidents?

☐ yes ☐ no

- Do you use an accident rate?

☐ yes ☐ no

- Which kind of rate is it? ☐ mortality rate
  ☐ injury rate
  ☐ global rate

Please, explain your evaluation method:

.....
.....
.....

- Results on safety performance are available for each type of roadside intervention?

☐ yes ☐ no

3. New developments and future systems

- Are you pleased with present solutions for roadside?

☐ yes ☐ no

- Do you think it would be implemented according to new safety principles?

☐ yes ☐ no

If yes, please explain how you improved/would improve this:

Safe side ditch designs have been developed.

Lighting columns are passively safe in 100 % of new installations, since year 1997, and existing columns have been modified to passively safe. Vertical signs since year 2000.

.....
.....
.....

- Do you agree effectiveness of interventions should be estimate with damages to people?

x☐ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

.....
.....
.....

- Do you know breakaway poles?

x☐ yes ☐ no

- Do/Would you use them on your roads?

x☐ yes ☐ no

Please, explain why yes/no:

http://alk.tiehallinto.fi/thohje/fen12b.pdf...**Passively safe vertical sign supports**.....

http://alk.tiehallinto.fi/thohje/pdf2/finnra_engineering_news_6.pdf.....**Passively safe lighting columns**.....

.....

.....

- Do you know shape and slope of escarpment can improve road safety?

x☐ yes ☐ no

- Do you use solution in Fig. 9?

☐ yes x☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

Rumble strips are used.

.....

.....

.....

Fig.9

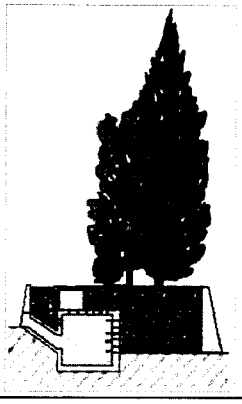

Fig.10

- Do you use solution in Fig.10 (false cutting)?

☐ yes x☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

.....

.....

.....

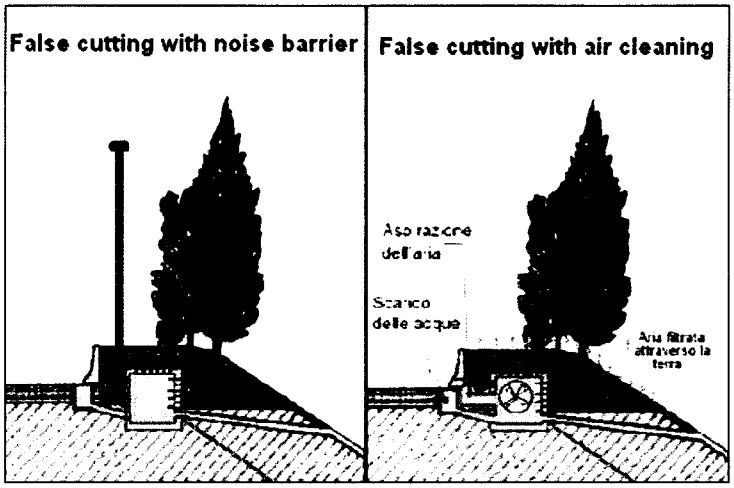

Fig.11

- Do you use solution in Fig.11 to drain water?

☐ yes x☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

The solutions prevents snow removal.

.....

.....

.....

- Do/Would you use false cutting with noise barrier (Fig.11)?

☐ yes x☐ no

Please explain why yes/no:

.....

.....

.....

- Do/Would you use solution in Fig.11 to clean air?

☐ yes x☐ no

Please explain why yes/no:

.....

.....

.....

- When you combine guard rail with noise barrier, which solution do you use?

☐ Solution with concrete guard rail (Fig.12)

☐ Solution with steel guard rail (Fig.13)

x☐ Both, it depends on cases

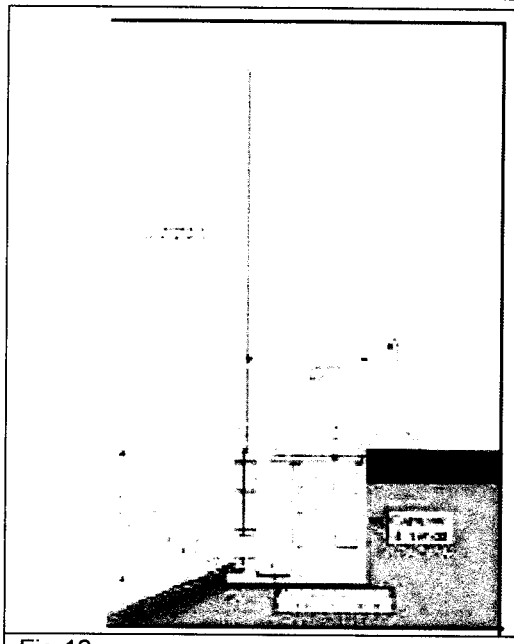

Fig.12

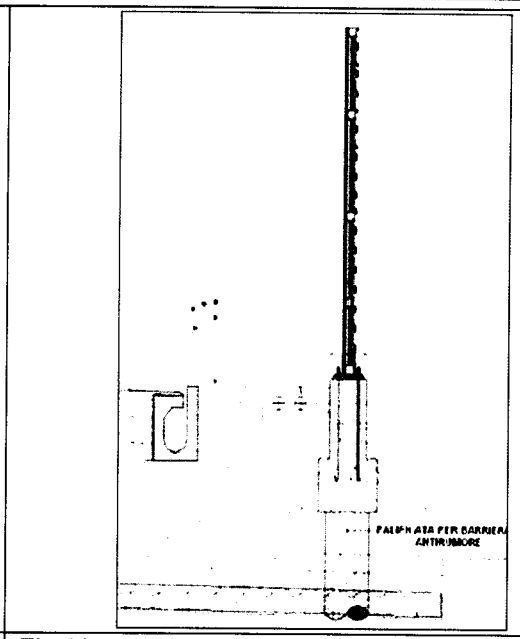

Fig.13

- Do you know rumble strips on road verge?

x☐ yes ☐ no

- Do/Would you use this type of intervention?

x☐ yes ☐ no

Please, explain why yes/no:

.....

.....

.....

- Which other new roadside intervention do you know? Please, give a short description.

http://alk.tiehallinto.fi/julkaisut/pdf2/3201124e-v-safety_of_roadside_area.pdf **Safe ditch desings**

.....

.....

.....

.....

.....

- Which system(s) would you prefer using and why?

.....

.....

.....

- Which system(s), in your opinion, will be the most used in the future and why?

.....

.....

.....

Thanks for answering our questionnaire. If you wish, we will provide you final results of our survey.

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- How you assess interventions
- New solutions for roadsides

1. General questions:

- Country **FRANCE**
- Length of rural network for which the National Road Authority is responsible:

Total network [km]:	20311
Motorways [km]:	11715
Highways (dual carriageway) [km]	2663
Highways (single carriageway) [km]:	5932
Others [km]:	…….....

2. Roadside treatments:

- Roadsides protected with safety barriers (approximately):

Motorways [%]:	100% on dual three lane motorway
Highways (dual carriageway) [%]:	Depending on lateral obstacles
Highways (single carriageway) [%]:	Depending on lateral obstacles
Others [%]:	Depending on lateral obstacles

- Type of roadsides: choose a value between 1 and 5 to evaluate how often they are protected with safety barriers (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	X	☐	☐
Cutting	☐	☐	X	☐	☐
Bridge roadside	☐	☐	☐	☐	X
Tunnel roadside	☐	X	☐	☐	☐

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1. **Slopes:**

- Do you consider the slope of the embankment as a factor to identify the potential safety hazard of the roadside element?

Xyes ☐ no

- Which is the reference standard/procedure for calculation?

- Handling lateral obstacles on main roads in open country - November 2002 - *Translate August 2007*

2. **Safety zone:**

- Do you define a safety zone outside of which hazards do not need to be protected/delineated?

Xyes ☐ no

- Which is the reference standard/procedure for calculation?

- Handling lateral obstacles on main roads in open country - November 2002 - *Translate August 2007*

- Do you consider shoulders as part of the safety zone?

Xyes ☐ no

- If you use safety zone, what criteria do you use to choose between safety zone or safety barrier?

- Handling lateral obstacles on main roads in open country - November 2002 - *Translate August 2007*

3. **Horizontal signs (markings):**

- Do you use special horizontal markings (e.g. rumble strips) on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	X	☐	☐
Cutting	☐	☐	X	☐	☐
Bridge roadside	X	☐	☐	☐	☐
Roadside with wall	X	☐	☐	☐	☐
Tunnel roadside	X	☐	☐	☐	☐

4. Vertical signs:

- Do you use roadside delineation to highlight the road edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	X	☐	☐	☐	☐
Cutting	X	☐	☐	☐	☐
Bridge roadside	☐	☐	X	☐	☐
Roadside with wall	X	☐	☐	☐	☐
Tunnel roadside	X	☐	☐	☐	☐

5. Other:

- Do you use other types of solution for protecting obstacles or delineating the roadside where there are hazards?

☐ yes Xno

Please, specify other system(s):

……
……
……

- Which other solution(s) do you use in tunnels?

……
……

- Which other solution(s) do you use on bridges?

……
……

- Which other solution(s) do you use for cuttings?

……
……

- Which other solution(s) do you use on embankments?

……
……

- Which type of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	X	☐	X	☐
Steel guard rails	X	X	X	X
Wire rope barriers	☐	☐	☐	☐
Horizontal sign	X	☐	X	☐
Delineation	☐	☐	☐	X
Other (specify)	☐	☐	☐	☐

3. Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	X
Investment costs	☐	☐	X	☐	☐
Maintenance costs	X	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	X	
Versatility	X	☐	☐	☐	☐

Comments:

……

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	X	☐	☐
Investment costs	☐	☐	X	☐	☐
Maintenance costs	☐	X	☐	☐	☐
Easy to use (assembly and maintenance)	☐	X	☐	☐	☐
Versatility	☐	☐	X	☐	☐

Comments:

……

Wire rope barriers	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments

We don't use this type of barrier……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	X	☐	☐
Investment costs	X	☐	☐	☐	☐
Maintenance costs	X	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	X	☐	☐
Versatility	☐	☐	X	☐	☐

Comments:

……

Delineation	1	2	3	4	5
Road safety	☐	☐	X	☐	☐
Investment costs	☐	☐	X	☐	☐
Maintenance costs	☐	X	☐	☐	☐
Easy to use (assembly and maintenance)	☐	X	☐	☐	☐
Versatility	☐	☐	☐	X	☐

Comments:

……

Other (specify)……..	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

……

- How do you assess safety performance? Do you use accident data?

  Xyes ☐ no

- Do you use an accident rate per traffic flow (e.g. per billion vehicle x km)?

  X yes ☐ no

- If yes, Which kind of rate is it? ☐ mortality rate (fatalities)

  ☐ injury rate (injured casualties)

  X global rate

Please explain your evaluation method:

……

……

……

- Are results on safety performance available for each type of roadside intervention?

  ☐ yes X no

4. New developments and future systems

- Are you satisfied with present treatments for roadside hazards?

Xyes ☐ no

- Do you think that adopting new safety principles would improve the situation?

X yes ☐

If yes, please explain how you improved/would improve this:

I think that ITS could probably improve the situation.

- Do you agree that the effectiveness of interventions should be estimated according to casualty numbers and severity of injury?

Xyes ☐ no

If yes, please explain how you evaluate/would evaluate this

I would better evaluate the effectiveness of barriers by taking into account severity of injury and delineation with both casualty numbers and severity of injury.

- Do you know of breakaway poles/lattix posts/breakaway lighting columns or other frangible devices?

X yes ☐ no

- Do/Would you use them on your roads?

Xyes ☐ no

Please, explain why yes/no:

We experiment this equipment

- Do you know that a change in the shape and slope of embankment slides can improve road safety?

Xyes ☐ no

- Do you use an unpaved shoulder (see Fig. 9)?

X yes Xno

- If no, would you use it?

☐ yes X no

Please, explain why yes/no:

It depends on the road. Anyway it seems to be better to use a stabilized soil and to avoid grass for a better grip.

Fig.9

- Do you use false cutting (see Fig.10)?

☐ yes Xno

- If no, would you use it?

☐ yes Xno

Please, explain why yes/no:

Probably no, because of investment and maintenance costs

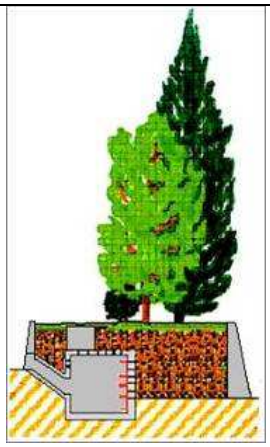

Fig.10

- Are you aware of shoulder rumble strips (see Fig. 14)?

xyes ☐ no

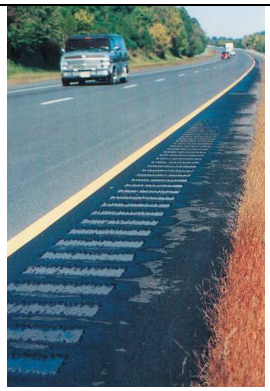

Fig.14

- Do/Would you use this type of intervention?

x yes ☐ no

Please, explain why yes/no and give a description of the type of shoulder rumble strip measure used:

We experiment rumble strips.

- Please give a short description of any other measure you are aware of.

……

……

……

……

……

- Which system(s) (measure) would you prefer to use and why?

……

……

……

- Which single system (measure) do you think offers the best potential for future use and safety benefits?

……

……

……

Please return completed questionnaires to: francesca.latorre@unifi.it

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- How you assess interventions
- New solutions for roadsides

1. General questions:

- Country Germany
- Length of rural network for which the National Road Authority is responsible:

Total network [km]:	~ 52,800 (rural roads and cross-town-links)
Motorways [km]:	~ 12,800
Highways (dual carriageway) [km]:	~ 3,700
Highways (single carriageway) [km]:	~36,200
Others [km]:	~ 8,000 (cross-town-links)

2. Roadside treatments:

- Roadsides protected with safety barriers (approximately):

Motorways [%]:	median: 100% roadside: depending on presence of hazards, no national database available
Highways (dual carriageway) [%]:	median ~99% roadside: see above
Highways (single carriageway) [%]:	?
Others [%]:	?

- Type of roadsides: choose a value between 1 and 5 to evaluate how often they are protected with safety barriers (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	x	☐	☐
Cutting	☐	☐	x	☐	☐
Bridge roadside	☐	☐	☐	☐	x*
Tunnel roadside	☐	x	☐	☐	☐

* speed limit above 50 km/h

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1. **Slopes:**

- Do you consider the slope of the embankment as a factor to identify the potential safety hazard of the roadside element?

X yes ☐ no

- Which is the reference standard/procedure for calculation?

Guideline: “Richtlinie für passiven Schutz an Straßen durch Fahrzeug-Rückhaltesysteme (RPS 2009)”

2. **Safety zone:**

- Do you define a safety zone outside of which hazards do not need to be protected/delineated?

X yes ☐ no

- Which is the reference standard/procedure for calculation?

Guideline: “Richtlinie für passiven Schutz an Straßen durch Fahrzeug-Rückhaltesysteme (RPS 2009)”

- Do you consider shoulders as part of the safety zone?

x yes ☐ no

- If you use safety zone, what criteria do you use to choose between safety zone or safety barrier?

If a hazard caused by an obstacle cannot be avoided, you have to shield it.

3. **Horizontal signs (markings):**

- Do you use special horizontal markings (e.g. rumble strips) on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	☐

*** Rumble strips are currently infrequently used on roads with a higher risk of run-off-the-road-accidents**

Vertical signs:

- Do you use roadside delineation to highlight the road edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	x
Cutting	☐	☐	☐	☐	x
Bridge roadside	☐	☐	☐	☐	x
Roadside with wall	☐	☐	☐	☐	x
Tunnel roadside	☐	☐	☐	☐	x

4. Other:

- Do you use other types of solution for protecting obstacles or delineating the roadside where there are hazards?

  x yes ☐ no

  Please, specify other system(s):

  static and dynamic warning signs, chevrons

- Which other solution(s) do you use in tunnels?

  reflectors, LEDs on kerbs

  ……

  ……

- Which other solution(s) do you use on bridges?
- Which other solution(s) do you use for cuttings?

  ……

  ……

- Which other solution(s) do you use on embankments?

  ……

  ……

- Which type of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	X	X	X	x
Wire rope barriers	☐	☐	☐	☐
Horizontal sign	x	x	x	x
Delineation	x	x	x	x
Other (specify)	☐	☐	☐	☐

roadside interventions

3. Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	x	☐
Investment costs	☐	☐	☐	☐	x
Maintenance costs	☐	☐	☐	x	☐
Easy to use (assembly and maintenance)	☐	☐	x	☐	☐
Versatility	☐	☐	x	☐	☐

Comments:

……

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	x	☐
Investment costs	☐	☐	☐	x	☐
Maintenance costs	☐	☐	☐	☐	x
Easy to use (assembly and maintenance)	☐	☐	x	☐	☐
Versatility	☐	☐	☐	x	☐

Comments:

……

Wire rope barriers	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

N.A.……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	x	☐
Investment costs	x	☐	☐	☐	☐
Maintenance costs	x	☐	☐	☐	☐
Easy to use (assembly and maintenance)	x	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	x

Comments:

……

Delineation	1	2	3	4	5
Road safety	☐	☐	☐	x	☐
Investment costs	x	☐	☐	☐	☐
Maintenance costs	x	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	x	☐	☐	☐
Versatility	☐	☐	☐	x	☐

Comments:

……

Other (specify)……..	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

……

- How do you assess safety performance? Do you use accident data?

  x yes ☐ no

- Do you use an accident rate per traffic flow (e.g. per billion vehicle x km)?

  x yes x no

- If yes, Which kind of rate is it? x mortality rate (fatalities)

  x injury rate (injured casualties)

  x global rate

Please explain your evaluation method:

accident analyses include threshold values for detection black spots as well as accident rates and accident cost rates for detailed analyses as well as for calculating the safety potential for network safety analyses

……

……

……

- Are results on safety performance available for each type of roadside intervention?

  ☐ yes x no

4. New developments and future systems

- Are you satisfied with present treatments for roadside hazards?

x yes ☐ no

- Do you think that adopting new safety principles would improve the situation?

x yes ☐ no

If yes, please explain how you improved/would improve this:

Current measures are suitable for protecting hazardous roadsides. Instruments of infrastructure safety management help to identify locations where to apply these measures.

……
……
……

- Do you agree that the effectiveness of interventions should be estimated according to casualty numbers and severity of injury?

If yes, please explain how you evaluate/would evaluate this:

Road safety improvements have to fit the given accident situation, therefore an evaluation method is important. Currently such a method is being developed by BASt and will be published as road safety handbook.

……
……
……

- Do you know of breakaway poles/lattix posts/breakaway lighting columns or other frangible devices?

x yes ☐ no

- Do/Would you use them on your roads?

x yes ☐ no

Please, explain why yes/no:

……
……
……

- Do you know that a change in the shape and slope of embankment slides can improve road safety?

x yes ☐ no

- Do you use an unpaved shoulder (see Fig. 9)?

x yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

……

……

……

Fig.9

- Do you use false cutting (see Fig.10)?

☐ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

? false cutting ?

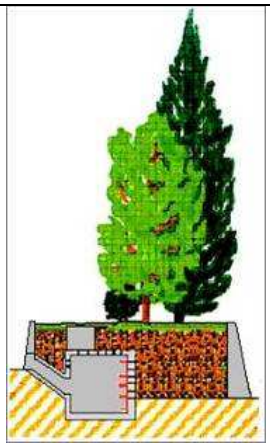

Fig.10

Are you aware of shoulder rumble strips (see Fig. 14)?

xyes ☐ no

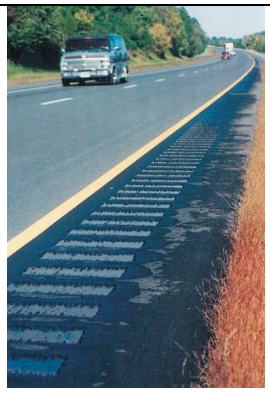

Fig.14

- Do/Would you use this type of intervention?

x yes ☐ no

Please, explain why yes/no and give a description of the type of shoulder rumble strip measure used:

Pilot project with milled rumble strips of motorways showed promising results, more stretches are planned to be realized in 2011

……

……

- Please give a short description of any other measure you are aware of.

……

……

……

……

……

- Which system(s) (measure) would you prefer to use and why?

Usually, several potential safety measures are suitable for safety improvements. Some might be the correct choice for one situation but not suitable for the next situation. Improvements have to fit to the safety needs and the given local situation.

- Which single system (measure) do you think offers the best potential for future use and safety benefits?

induce calm driving, make roadside forgiving

……

……

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QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- How you assess interventions
- New solutions for roadsides

1. General questions:

- Country ICELAND
- Length of rural network for which the National Road Authority is responsible:

Total network [km]:	12730 km
Motorways [km]:	0
Highways (dual carriageway) [km]:	24 km+ 5 km (2+1)
Highways (single carriageway) [km]:	4339 (main roads, rural network)
Others [km]:	8362 (minor roads, rural network)

2. Roadside treatments:

- Roadsides protected with safety barriers (approximately):

Motorways [%]:	0
Highways (dual carriageway) [%]:	3-4%
Highways (single carriageway) [%]:	2%
Others [%]:	<0,5%

- Type of roadsides: choose a value between 1 and 5 to evaluate how often they are protected with safety barriers (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	x☐	☐	☐
Cutting	☐	x☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	x☐
Tunnel roadside	☐	x☐	☐	☐	☐

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1. **Slopes:**

- Do you consider the slope of the embankment as a factor to identify the potential safety hazard of the roadside element?

x☐ yes ☐ no

- Which is the reference standard/procedure for calculation?

Icelandic Road Design Guidelines:

http://www.vegagerdin.is/upplysingar-og-utgafa/leidbeiningar-og-stadlar/veghonnunarreglur/

Within the safety zone, according to the minimum requirements, the slope of the embankment should be 1:3 or less for 90 km/hour design speed, but not steeper than 1:4 if the design speed is higher than 90 km/hour.

……

2. **Safety zone:**

- Do you define a safety zone outside of which hazards do not need to be protected/delineated?

x☐ yes ☐ no

- Which is the reference standard/procedure for calculation?

http://www.vegagerdin.is/upplysingar-og-utgafa/leidbeiningar-og-stadlar/veghonnunarreglur/

The width of the safety zone depends on the design speed and the Average Annual Daily Traffic on the road in question. F.ex., the width of the safety zone is 9 m on a road with design speed 90 km/hour and AADT >3000 cars/day.

……

- Do you consider shoulders as part of the safety zone?

x☐ yes ☐ no

- If you use safety zone, what criteria do you use to choose between safety zone or safety barrier?

The main rule is not to put up a safety barrier unless an adequate safety zone cannot be provided. In other words, a safety barrier is never the first alternative. One also has to check an extra width outside the safety zone. F.ex., if there is water, deeper than 0,5m, within a width of 1,5 times the width of the safety zone, than a safety barrier must be put up.

3. **Horizontal signs (markings):**

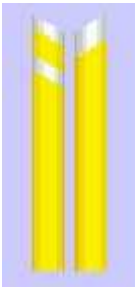
- Do you use special horizontal markings (e.g. rumble strips) on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

The main purpose with rumble strips in Iceland is to make the driver alert if he is going to drive off the road or over to the lane for on-coming traffic. More than 60% of the rumble strips on Icelandic roads are used between driving directions. There is an interest in making more rumble strips but one of our problems is that they can only be “cut” into roads with asphalt on but many of our roads are surface dressed and that kind of surface does not allow normal rumble strips.

Type of roadside	1	2	3	4	5
Embankment	☐	☐	x☐	☐	☐
Cutting	☐	x☐	☐	☐	☐
Bridge roadside	☐	x☐	☐	☐	☐
Roadside with wall	☐	x☐	☐	☐	☐
Tunnel roadside	☐	x☐	☐	☐	☐

4. Vertical signs:

- Do you use roadside delineation to highlight the road edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):



Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	x☐	☐
Cutting	☐	☐	☐	x☐	☐
Bridge roadside	☐	☐	☐	☐	x☐
Roadside with wall	☐	☐	☐	☐	x☐
Tunnel roadside	☐	☐	☐	☐	x☐

5. Other:

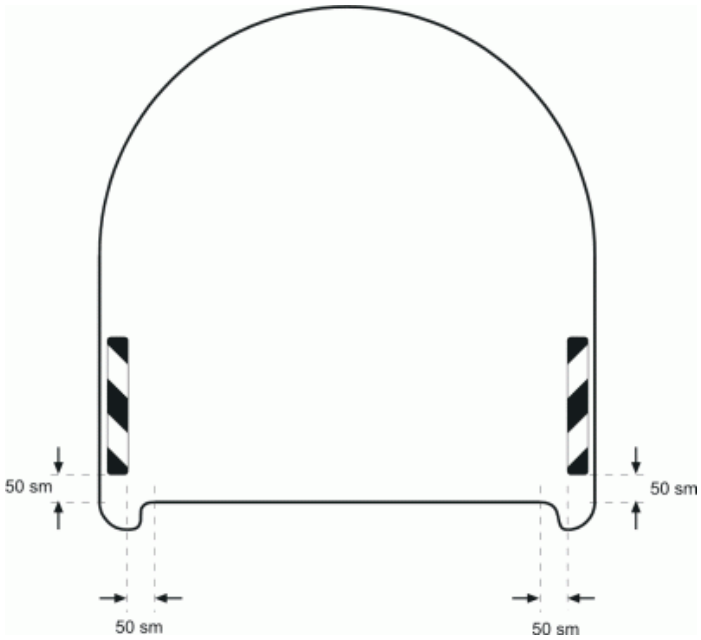
- Do you use other types of solution for protecting obstacles or delineating the roadside where there are hazards?

x☐ yes ☐ no

Please, specify other system(s):

We use chevrons to warn drivers of sharp bends.

- Which other solution(s) do you use in tunnels?



- Which other solution(s) do you use on bridges?

  Reflectors on the safety barrier.

- Which other solution(s) do you use for cuttings?

  None.

- Which other solution(s) do you use on embankments?

  None.

- Which type of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	☐	x☐	x☐	x☐
Wire rope barriers	☐	x☐	x☐	x☐
Horizontal sign	☐	x☐	x☐	☐
Delineation	☐	x☐	x☐	x☐
Other (specify) *chevrons if the alignment requires (f.ex. at sharp bends)*	☐	x☐	x☐	x☐

3. Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

We do not use concrete guard rails in general but often when road work is going on.

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	x☐	☐
Investment costs	☐	☐	☐	x☐	☐
Maintenance costs	☐	☐	☐	x☐	☐
Easy to use (assembly and maintenance)	☐	☐	x☐	☐	☐
Versatility	☐	☐	x☐	☐	☐

Comments:

Somewhere we cannot use them because of problems with snow.

Wire rope barriers	1	2	3	4	5
Road safety	☐	☐	☐	x☐	☐
Investment costs	☐	☐	x☐	☐	☐
Maintenance costs	☐	☐	x☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	x☐
Versatility	☐	☐	x☐	☐	☐

Comments:

Very good experence of wire ropes in Iceland. No problem with snow.

A new type of wire rope barriers that can be put into the slope are promising.
……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	x☐
Investment costs	☐	☐	x☐	☐	☐
Maintenance costs	x☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	x☐	☐	☐
Versatility	☐	☐	x☐	☐	☐

Comments:

Regarding versatility I refer to my text above about rumble strips.

Delineation	1	2	3	4	5
Road safety	☐	☐	☐	☐	x☐
Investment costs	x☐	☐	☐	☐	☐
Maintenance costs	x☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	x☐
Versatility	☐	☐	☐	☐	x☐

Comments:

……

Other (specify)…chevrons	1	2	3	4	5
Road safety	☐	☐	☐	☐	x☐
Investment costs	x☐	☐	☐	☐	☐
Maintenance costs	x☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	x☐
Versatility	☐	☐	☐	☐	x☐

Comments: In general it can be said that snow clearing causes some damage on safety barriers, road signs and some other road equipment.

- How do you assess safety performance? Do you use accident data?

  x☐ yes ☐ no

- Do you use an accident rate per traffic flow (e.g. per billion vehicle x km)?

  x☐ yes ☐ no

- If yes, Which kind of rate is it? x☐ mortality rate (fatalities)

  x☐ injury rate (injured casualties)

  x☐ global rate

Please explain your evaluation method: Some of the solutions above, f.ex. delineation, and the use of safety barriers on new roads, are standard, i.e. used proactively. Other solutions are used both proactively and reactively. We have been working systematically towards eliminating black spots for several years but we have not done many after studies yet. However, we have no reason to believe that f.ex. the safety barriers we have been putting up on old roads have not worked properly. The first rumble strips were made in 2007.

- Are results on safety performance available for each type of roadside intervention?

  ☐ yes x☐ no, use foreign handbooks

4. New developments and future systems

- Are you satisfied with present treatments for roadside hazards?

☐ yes x☐ no

- Do you think that adopting new safety principles would improve the situation?

x☐ yes ☐ no

If yes, please explain how you improved/would improve this:

The solutions for motorcyclists are not good enough. Something has to be done to make it less dangerous for motorcyclists to collide with the pillars of safety barriers (steel guardrails and wire rope barriers).

……
……
……

- Do you agree that the effectiveness of interventions should be estimated according to casualty numbers and severity of injury?

x☐ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

By using before and after studies.

- Do you know of breakaway poles/lattix posts/breakaway lighting columns or other frangible devices?

x☐ yes ☐ no

- Do/Would you use them on your roads?

x☐ yes ☐ no

Please, explain why yes/no:

According to the Icelandic Road Design Guidelines only poles that have been approved by IS-EN-12767 may be used within the safety zone. Serious accidents have happened when drivers have driven into old poles which were not approved by IS-EN-12767.

- Do you know that a change in the shape and slope of embankment slides can improve road safety?

x☐ yes ☐ no

- Do you use an unpaved shoulder (see Fig. 9)?

x☐ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

Unpaved shoulders are still in use on older roads. According to the Icelandic Road Design Guidelines, see:

http://www.vegagerdin.is/upplysingar-og-utgafa/leidbeiningar-og-stadlar/veghonnunarreglur/

shoulders should be paved in general.

Fig.9

- Do you use false cutting (see Fig.10)?

☐ yes x☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

Cannot comment.

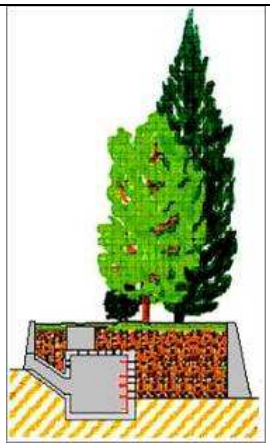


Fig.10

- Are you aware of shoulder rumble strips (see Fig. 14)?

x☐ yes ☐ no

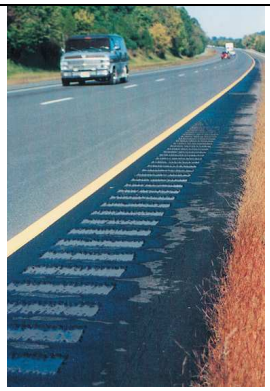


Fig.14

- Do/Would you use this type of intervention?

x☐ yes ☐ no

Please, explain why yes/no and give a description of the type of shoulder rumble strip measure used:

- The main purpose with rumble strips in Iceland is to make the driver alert if he is going to drive off the road or over to the lane for on-coming traffic. More than 60% of the rumble strips on Icelandic roads are used between driving directions. There is an interest in making more rumble strips but one of our problems is that they can only be “cut” into roads with asphalt on but many of our roads are surface dressed and that kind of surface does not allow normal rumble strips.
- Please give a short description of any other measure you are aware of.

…….Chevrons at sharp bends.

……

- Which system(s) (measure) would you prefer to use and why?

Variable message signs warning drivers when there suddenly is black-ice on the road surface. The Icelandic Road Administration operates automatic weather-stations at many spots so the data is already available.

- Which single system (measure) do you think offers the best potential for future use and safety benefits?

I believe that a safety zone of adequate width and road equipment which is approved by IS-EN_12767 together will give the most safety benefits.

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- How you assess interventions
- New solutions for roadsides

1. General questions:

- Country IRELAND
- Length of rural network for which the National Road Authority is responsible:

  Total network [km]: 5428

  Motorways [km]: 881

  Highways (dual carriageway) [km]: 283 + 49 (2 plus 1)

  Highways (single carriageway) [km]: 4215

  Others [km]: ……..

2. Roadside treatments:

- Roadsides protected with safety barriers (approximately):

  Motorways [%]: 10%

  Highways (dual carriageway) [%]: 10%

  Highways (single carriageway) [%]: 5%

  Others [%]: ……..

- Type of roadsides: choose a value between 1 and 5 to evaluate how often they are protected with safety barriers (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	**X**	☐	☐
Cutting	☐	**X**	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	**X**
Tunnel roadside	☐	☐	☐	**X**	☐

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1. **Slopes:**

- Do you consider the slope of the embankment as a factor to identify the potential safety hazard of the roadside element?

X yes ☐ no

- Which is the reference standard/procedure for calculation?

NRA DMRB TD 19/09

http://www.nra.ie/Publications/RoadDesignConstructionStandards/NRADesignManualforRoadsBridgesJan2009/

2. **Safety zone:**

- Do you define a safety zone outside of which hazards do not need to be protected/delineated?

X yes ☐ no

Which is the reference standard/procedure for calculation? NRA DMRB TD 19/09

http://www.nra.ie/Publications/RoadDesignConstructionStandards/NRADesignManualforRoadsBridgesJan2009/

- Do you consider shoulders as part of the safety zone?

X yes ☐ no

- If you use safety zone, what criteria do you use to choose between safety zone or safety barrier?

See NRA DMRB TD 19/09

http://www.nra.ie/Publications/RoadDesignConstructionStandards/NRADesignManualforRoadsBridgesJan2009/

3. **Horizontal signs (markings):**

- Do you use special horizontal markings (e.g. rumble strips) on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	**X**	☐
Cutting	☐	☐	☐	**X**	☐
Bridge roadside	☐	☐	☐	**X**	☐
Roadside with wall	☐	☐	☐	**X**	☐
Tunnel roadside	☐	☐	☐	**X**	☐

4. Vertical signs:

- Do you use roadside delineation to highlight the road edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	**X**	☐
Cutting	☐	☐	☐	**X**	☐
Bridge roadside	☐	☐	☐	**X**	☐
Roadside with wall	☐	☐	☐	**X**	☐
Tunnel roadside	☐	☐	☐	**X**	☐

5. Other:

- Do you use other types of solution for protecting obstacles or delineating the roadside where there are hazards?

  X yes ☐ no

  Please, specify other system(s):

  More and more we are using Vehicle Activated Signs with associated warning signals to alert drivers to sharp bends ahead or other hazards.

- Which other solution(s) do you use in tunnels?

  None

- Which other solution(s) do you use on bridges?

  None

- Which other solution(s) do you use for cuttings?

  None

- Which other solution(s) do you use on embankments?

  None

- Which type of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	**X**	☐	**X**	☐
Wire rope barriers	☐	☐	☐	☐
Horizontal sign	☐	**X**	☐	☐
Delineation	☐	**X**	☐	☐
Other (specify)	☐	☐	☐	☐

3. Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	**X**	☐	☐
Investment costs	☐	☐	☐	**X**	☐
Maintenance costs	**X**	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	**X**	☐	☐
Versatility	☐	**X**	☐	☐	☐

Comments:

……

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	**X**
Investment costs	☐	☐	**X**	☐	☐
Maintenance costs	☐	☐	**X**	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	**X**	☐
Versatility	☐	☐	**X**	☐	☐

Comments:

……

Wire rope barriers	1	2	3	4	5
Road safety	☐	☐	☐	**X**	☐
Investment costs	☐	**X**	☐	☐	☐
Maintenance costs	☐	**X**	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	**X**	☐
Versatility	☐	☐	☐	☐	**X**

Comments:

……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	**X**
Investment costs	☐	**X**	☐	☐	☐
Maintenance costs	☐	**X**	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	**X**	☐
Versatility	☐	☐	☐	☐	**X**

Comments:

……

Delineation	1	2	3	4	5
Road safety	☐	☐	☐	☐	**X**
Investment costs	☐	**X**	☐	☐	☐
Maintenance costs	☐	**X**	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	**X**	☐
Versatility	☐	☐	☐	☐	**X**

Comments:

……

Other (specify)……..	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

……

- How do you assess safety performance? Do you use accident data?

  X yes ☐ no

- Do you use an accident rate per traffic flow (e.g. per billion vehicle x km)?

  X yes ☐ no

- If yes, Which kind of rate is it? **X** mortality rate (fatalities)

  injury rate (injured casualties)

  ☐ global rate

Please explain your evaluation method:

See document called Review_of_the_National_Primary_and_Secondary_Road_Network.pdf on CEDR TG RS website under CEDR/2_TD_Construction/T9_10_TG3_Road_Safety/EU_RISM_Directive/

http://www.cedr.fr/home/fileadmin/user_upload/en/Thematic_Domains/Strat_plan_2_2009-2013/2_TD_Construction/T9_10_TG3_Road_Safety/EU_RISM_Directive/Review_of_the_National_Primary_and_Secondary_Road_Network.pdf

- Are results on safety performance available for each type of roadside intervention?

  ☐ yes **X** no (we use a Global CMF rate)

4. New developments and future systems

- Are you satisfied with present treatments for roadside hazards?

☐ yes **X** no

- Do you think that adopting new safety principles would improve the situation?

X yes ☐ no

If yes, please explain how you improved/would improve this:

Some of our standards need to be reviewed, especially when used on D&B and PPP schemes.

- Do you agree that the effectiveness of interventions should be estimated according to casualty numbers and severity of injury?

X yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

We measure reduction is collision numbers, as well as factoring in collision costs based on 'Willingness To Pay' principle

- Do you know of breakaway poles/lattix posts/breakaway lighting columns or other frangible devices?

X yes ☐ no

- Do/Would you use them on your roads?

X yes ☐ no

Please, explain why yes/no:

We have used lattix posts in the past, but due to their high cost we are now using a framework of tubular steel which gives the same effect at much reduced cost.

- Do you know that a change in the shape and slope of embankment slides can improve road safety?

X yes ☐ no

- Do you use an unpaved shoulder (see Fig. 9)?

☐ yes **X** no

- If no, would you use it?

X yes ☐ no

Please, explain why yes/no:

We would use it as it gives the driver an extra safety factor in cases or driver error.

Fig.9

- Do you use false cutting (see Fig.10)?

☐ yes **X** no

- If no, would you use it?

☐ yes **X** no

Please, explain why yes/no:

To clarify, we have used them in situations where there is a difference in level between different sides of a motorway or dual carriageway, but this is the only use we make of them.

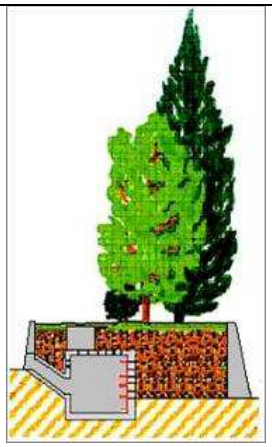


Fig.10

- Are you aware of shoulder rumble strips (see Fig. 14)?

X yes ☐ no

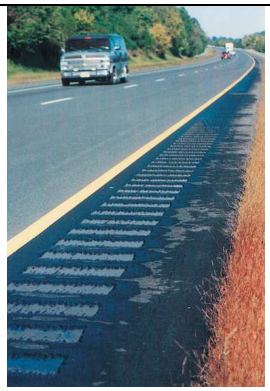


Fig.14

- Do/Would you use this type of intervention?

X yes ☐ no

Please, explain why yes/no and give a description of the type of shoulder rumble strip measure used:

We use shoulder rumble strips on both medians of our motorways, as well as the roadside edges, as they alert the driver that they are wandering off the roadway.

- Please give a short description of any other measure you are aware of.

More and more we are using Vehicle Activated Signs with associated warning signals to alert drivers to sharp bends ahead or other hazards.

- Which system(s) (measure) would you prefer to use and why?

We are also developing a vehicle activated system to warn Ghost drivers (wrong way drivers) where they are entering the motorway in the wrong direction.

- Which single system (measure) do you think offers the best potential for future use and safety benefits?

More and more ITS type developments will come on stream that I expect to be of benefit in the road safety area.

QUESTIONNAIRE
ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided in three parts. The first part includes general questions about length of network and type of roadside implemented interventions. In the second part there are some questions to assess interventions mentioned in 1st part. The last part includes questions about new type of solutions to improve roadside safety.

1. General questions:

- Country ITALIA
- Length of network:

  Total network [km]: 22000 km

  Motorways [km]: 1000 km

  Highways (single carriageway) [km]: 17200km

  Highways (dual carriageway) [km]: 4000km

  Others [km]: 800km
- Saved with interventions on roadside (approximately):

  Motorways [km]: 10% tunnels-cutting, 60% embankment and 100% bridge roadside

  Highways (single/dual carriageway) [km]: 5% tunnels-cutting, 60% embankment and 100% bridge roadside

  Others [km]: %
- Type of roadsides: choose a value between 1 and 5 to evaluate how often are saved (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☒	☐
Cutting	☐	☒	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☒
Tunnel roadside	☐	☒	☐	☐	☐

- Which of the following systems are used on your roadsides?

1. Concrete guard rails:

☒ yes ☐ no

- Please, specify if you use it in the following roadsides:

Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment (Fig.1)	☐	☒	☐	☐	☐
Cutting (Fig.2)	☐	☐	☐	☒	☐
Bridge roadside (Fig.3)	☐	☒	☐	☐	☐
Roadside with wall (Fig.4)	☐	☐	☐	☒	☐
Tunnel roadside (Fig.4)	☐	☒	☐	☐	☐

Fig.1

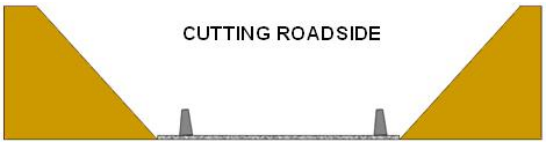


Fig.2

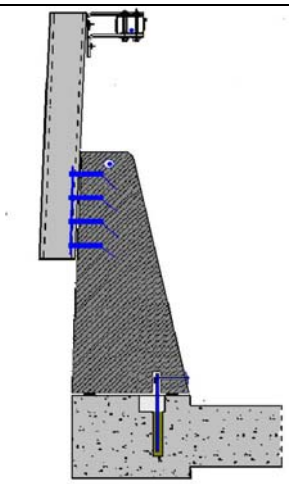


Fig.3

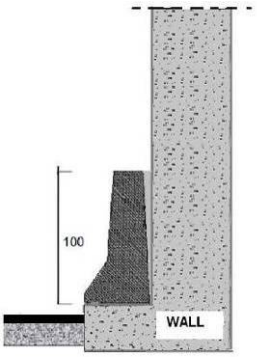


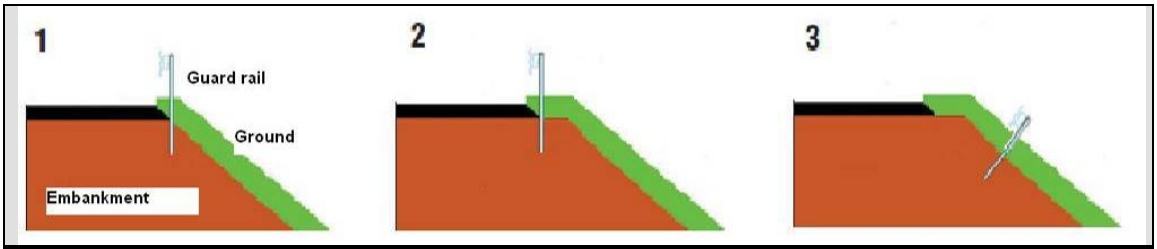
Fig.4

2. Steel guard rails:

☒ yes ☐ no

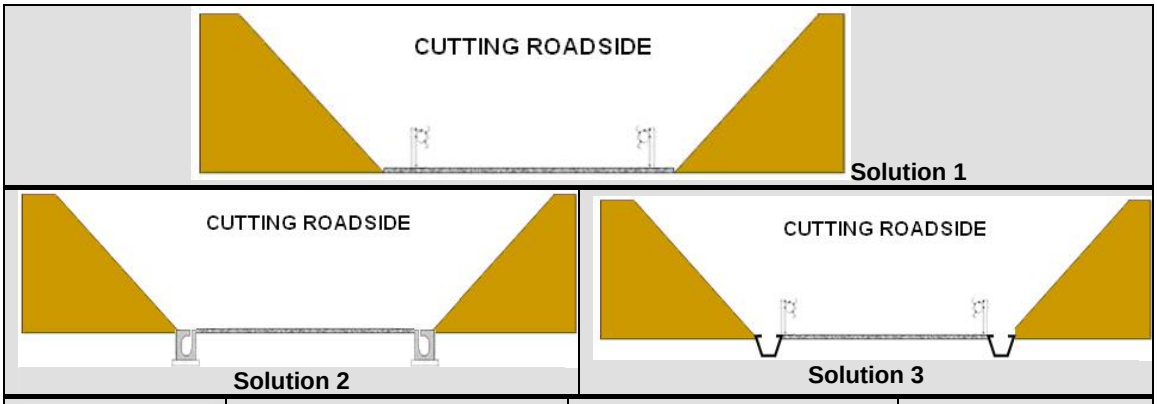
Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment	☒	☐	☐	☐	☐
Cutting	☐	☐	☐	☒	☐
Bridge roadside	☒	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☒	☐
Tunnel roadside	☐	☐	☐	☐	☒

- Embankment: looking at figure below, which kind of solution do you use?



	Solution 1	**Solution 2**	**Solution 3**
The most used	☒	☐	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☒	☐
Not used	☐	☐	☒

- Cutting: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	☒	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	☒
Not used	☒	☐	☐

3. Horizontal sign:

☒ yes ☐ no

- Do you always use horizontal sign on roadsides to highlight the edge? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☒
Cutting	☐	☐	☐	☐	☒
Bridge roadside	☐	☐	☐	☐	☒
Roadside with wall	☐	☐	☐	☐	☒
Tunnel roadside	☐	☐	☐	☐	☒

- Do you use horizontal sign like shown in Fig.5?

☒ yes ☐ no

- Please explain why yes/no:

Yes, in particular, this type of horizontal sign (black and white diagonal stripes) is used to inhibit the crossing in the black and white area, without physical. In this way the visibility remain high and the temporary stop is only possible in case of emergency.

	
Fig.5	Fig.6

4. Vertical sign:

☒ yes ☐ no

- Do you use vertical sign on roadsides to highlight edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☒	☐
Cutting	☐	☐	☐	☒	☐
Bridge roadside	☐	☐	☐	☒	☐
Roadside with wall	☐	☐	☐	☒	☐
Tunnel roadside	☐	☐	☐	☒	☐

- Do you use vertical sign like example shown in Fig.6?

☒ yes ☐ no

- Please, explain why yes/no:

When a curve has occasionally a radius of curvature less than that normally allowed for in the category of road when the deviation of direction produced by the curve exceeds 90°.

5. Fences:

- Do you use fences on bridge roadside like Fig.7?

☒ yes ☐ no

- Is it always combined with steel guard rail?

☐ yes ☒ no

- Please, explain if you use a different combination:

The fence is also combined with concrete guard rail.

	
Fig.7	Fig.8

6. Walls:

- Do you use wall on road side like Fig.8?

  ☐ yes ☒no

- Choose a value between 1 and 5 to evaluate how often is used in following roadside (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☒	☐	☐	☐	☐
Cutting	☐	☐	☐	☒	☐
Bridge roadside	☐	☒	☐	☐	☐

7. Other:

- Do you use other type of solution for roadside?

  ☒ yes ☐ no

Please, specify other system(s):

- Milled (engraved) horizontal sign in extremely hazardous zones or in fog zones . The effect is similar to the rumble strips;
- Short shutdown area.

Which other solution(s) do you use in tunnel?

Milled (engraved) horizontal sign.

- Which other solution(s) do you use on bridge?

……

Which other solution(s) do you use in cutting?

……

……

- Which other solution(s) do you use on embankment?

False cutting in embankment with a ground stripe that simulates the cutting roadside with or without guard rail.

- Which kind of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☒	☐	☐	☐
Steel guard rails	☒	☒	☒	☒
Horizontal sign	☒	☒	☒	☒
Vertical sign	☒	☒	☒	☒
Fences	☒	☒	☒	☒
Walls	☐	☐	☐	☒
Other	☐	☐	☐	☐

2. Assessment of implemented interventions

- How do you assess every intervention implemented in your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☒
Investment costs	☐	☒	☐	☐	☐
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☒	☐	☐	☐	☐
Versatility	☐	☐	☐	☒	☐

Comments:

Minimum maintenance costs, speed of installation.

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☐	☐	☒
Maintenance costs	☐	☐	☐	☐	☒
Easy to use (assembly and maintenance)	☒	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☒

Comments:

Requires more space and allows repairs after incident.

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☒	☐	☐	☐
Maintenance costs	☐	☐	☒		☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☒
Versatility	☐	☐	☐	☐	☒

Comments:

……

Vertical sign	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☒	☐	☐
Maintenance costs	☐	☐	☒	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☒
Versatility	☐	☐	☐	☐	☒

Comments:

……

Fences	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☒	☐	☐
Maintenance costs	☐	☐	☒	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☐	☒	☐

Comments:

Safety effect is quite high for bridges where people might drop things on the underlying road or rail. They are also used in areas with wild or domestic animals.

Walls	1	2	3	4	5
Road safety	☐	☒	☐	☐	☐
Investment costs	☒	☐	☐	☐	☐
Maintenance costs	☒	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☐	☒	☐

Comments:

They aren't built for the safety of the roadside.

Other (specify)	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☒	☐	☐
Maintenance costs	☐	☒	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☒	☐	☐
Versatility	☐	☐	☒	☐	☐

Comments:

……

- How do you estimate safety performance? Do you use data of accidents?

☒ yes ☐ no

- Do you use an accident rate?

☒ yes ☐ no

- Which kind of rate is it? ☐ mortality rate
  ☐ injury rate
  ☒ global rate = mortality + injury

Please, explain your evaluation method: detailed analysis of run-off accidents considering fatalities and injury accidents including detailed accident data:

- Results on safety performance are available for each type of roadside intervention?

☐ yes ☒ no

3. New developments and future systems

- Are you pleased with present solutions for roadside?

☐yes ☒ no

- Do you think it would be implemented according to new safety principles?

☒ yes ☐no

If yes, please explain how you improved/would improve this:

- Measurement of the safety infrastructures given by combining global rate and injury rate;
- Elimination of isolated obstacles and steep slope embankment, increase of false cuttings.

- Do you agree effectiveness of interventions should be estimate with damages to people?

☒ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

Having available large amounts of data about global rate we can eliminate human behavior and identify only issues related to infrastructure.

- Do you know breakaway poles?

☒ yes ☐ no

- Do/Would you use them on your roads?

☒ yes ☐ no

Please, explain why yes/no:

No need for use on motorway network, but might work on rural roads with lower speeds.

- Do you know shape and slope of escarpment can improve road safety?

☒ yes ☐ no

- Do you use solution in Fig. 9?

☐ yes ☒ no

- If no, would you use it?

☐ yes ☒ no

Please, explain why yes/no:

We prefer to use embossed horizontal sign.

Fig.9

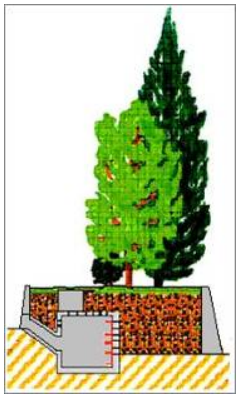


Fig.10

- Do you use solution in Fig.10 (false cutting)?

☒ yes ☐ no

- If no, would you use it?

☒ yes ☐ no

Please, explain why yes/no:

Because it's a little-known solution.

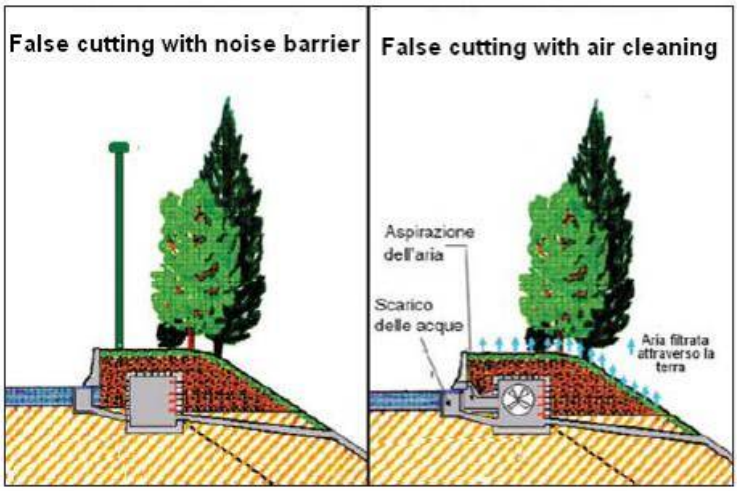


Fig.11

- Do you use solution in Fig.11 to drain water?

☐yes ☒ no

- If no, would you use it?

☒ yes ☐ no

Please, explain why yes/no:

Is not currently used because it is very expensive, but we should develop it in areas of high population density.

- Do/Would you use false cutting with noise barrier (Fig.11)?

☒ yes ☐ no

Please explain why yes/no:

Because the false cutting facilitates the insertion of noise barriers.

- Do/Would you use solution in Fig.11 to clean air?

☐ yes ☒ no

Please explain why yes/no:

High costs

- When you combine guard rail with noise barrier, which solution do you use?

☐ Solution with concrete guard rail (Fig.12)

☐ Solution with steel guard rail (Fig.13)

☒ Both, it depends on cases

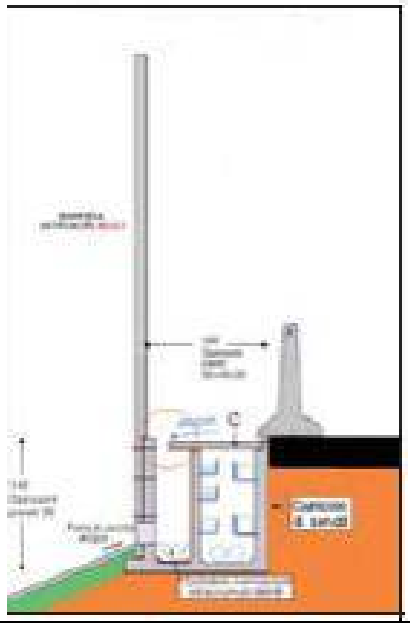


Fig.12

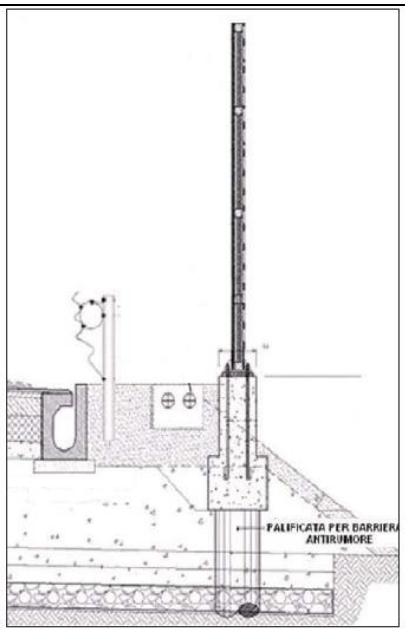


Fig.13

- Do you know rumble strips on road verge?

☒ yes ☐ no

- Do/Would you use this type of intervention?

☒ yes ☐ no

Please, explain why yes/no:

Benefit-Cost high.

- Which other new roadside intervention do you know? Please, give a short description.

We prefer use crash cushions with large front shock absorbers to facilitate the interception off the device by vulnerable road users.

- Which system(s) would you prefer using and why?

Roads without roadside and with steep slope obstacles.

- Which system(s), in your opinion, will be the most used in the future and why?

Concrete and steel depending on the local situation

Thanks for answering our questionnaire. If you wish, we will provide you final results of our survey.

QUESTIONNAIRE
ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided in three parts. The first part includes general questions about length of network and type of roadside implemented interventions. In the second part there are some questions to assess interventions mentioned in 1st part. The last part includes questions about new type of solutions to improve roadside safety.

1. General questions:

- Country: Lithuania
- Length of network:
  - Total network [km]: 21320,232 km
  - Motorways [km]: 309,11 km
  - Highways (single carriageway) [km]: .....
  - Highways (dual carriageway) [km]: .....
  - Others [km]: 19571,776 km
- Saved with interventions on roadside (approximately):
  - Motorways [km]: 445 km
  - Highways (single carriageway) [km]: .....
  - Highways (dual carriageway) [km]: .....
  - Others [km]: 1425 km (total)
- Type of roadsides: choose a value between 1 and 5 to evaluate how often are saved (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	√	☐
Cutting	☐	☐	√	☐	☐
Bridge roadside	☐	☐	☐	☐	√
Tunnel roadside	√	☐	☐	☐	☐

- Which of the following systems are used on your roadsides?

1. Concrete guard rails:

☐ yes √ no

- Please, specify if you use it in the following roadsides:

Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment (Fig.1)	☐	☐	☐	☐	☐
Cutting (Fig.2)	☐	☐	☐	☐	☐
Bridge roadside (Fig.3)	☐	☐	☐	☐	☐
Roadside with wall (Fig.4)	☐	☐	☐	☐	☐
Tunnel roadside (Fig.4)	☐	☐	☐	☐	☐

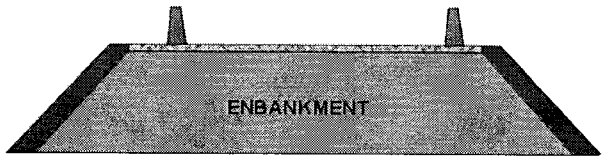


Fig.1

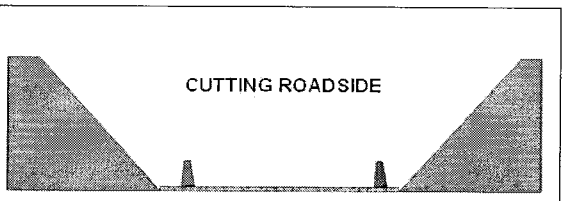


Fig.2

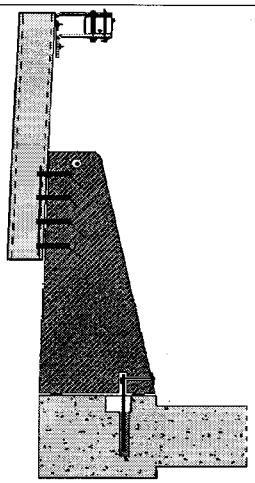


Fig.3

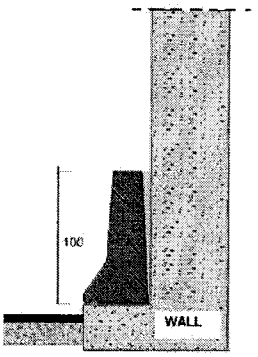


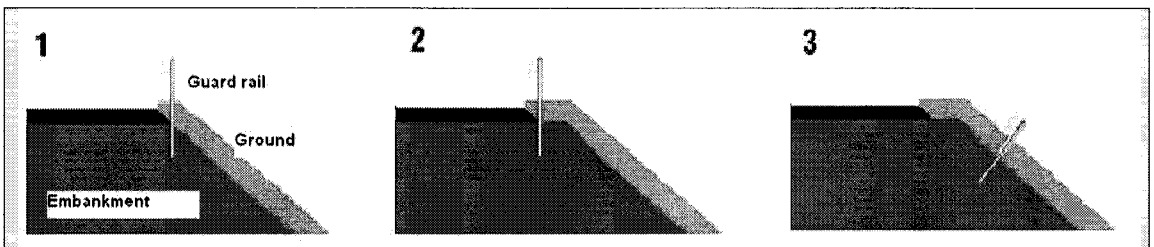
Fig.4

2. Steel guard rails:

√ yes ☐ no

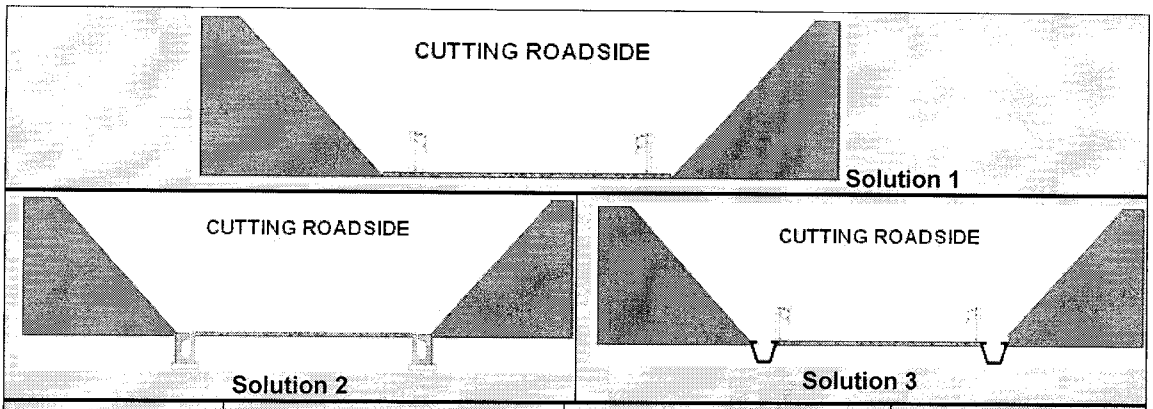
Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment	√	☐	☐	☐	☐
Cutting	☐	☐	☐	√	☐
Bridge roadside	√	☐	☐	☐	☐
Roadside with wall	√	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	√	☐

- Embankment: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	√	☐
The least used	√	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	☐
Not used	☐	☐	√

- Cutting: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	√	☐
The least used	√	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	√
Not used	☐	☐	☐

3. Horizontal sign:

√ yes ☐ no

- Do you always use horizontal sign on roadsides to highlight the edge? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	√
Cutting	☐	☐	☐	☐	√
Bridge roadside	☐	☐	☐	☐	√
Roadside with wall	√	☐	☐	☐	☐
Tunnel roadside	√	☐	☐	☐	☐

- Do you use horizontal sign like shown in Fig.5?

√ yes ☐ no

- Please explain why yes/no:

1) to separate traffic movement
2) to require prompt attention, represent an immediate or imminent hazard

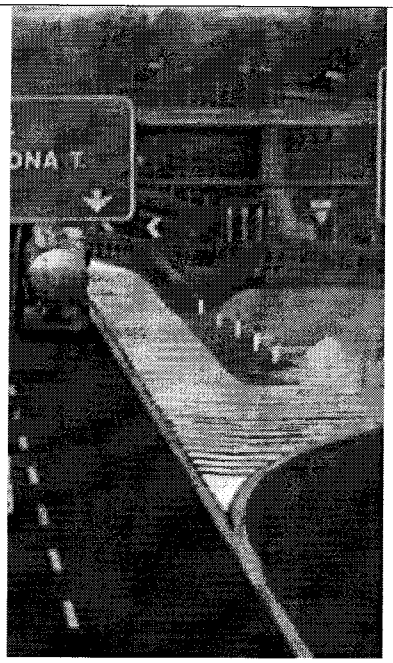


Fig.5

Fig.6

4. Vertical sign:

√ yes ☐ no

- Do you use vertical sign on roadsides to highlight edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	√
Cutting	☐	☐	☐	☐	√
Bridge roadside	☐	☐	☐	☐	√
Roadside with wall	√	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	√

- Do you use vertical sign like example shown in Fig.6?

√ yes ☐ no

- Please, explain why yes/no:

to inform about curve

5. Fences:

- Do you use fences on bridge roadside like Fig.7?

☐ yes √ no

- Is it always combined with steel guard rail?

☐ yes √ no

- Please, explain if you use a different combination:

.....

.....

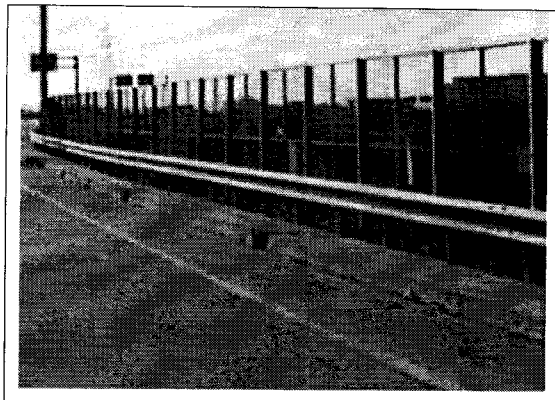


Fig.7

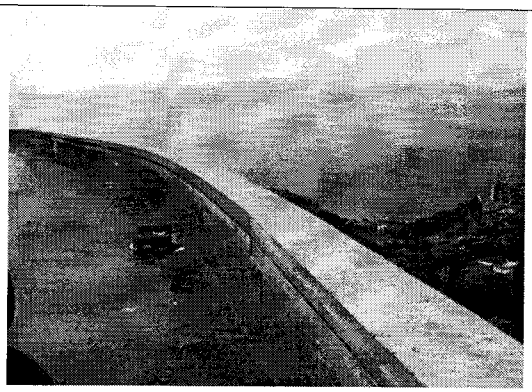


Fig.8

6. Walls:

- Do you use wall on roadside like Fig.8?

  ☐ yes √ no

- Choose a value between 1 and 5 to evaluate how often is used in following roadside (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐

7. Other:

- Do you use other type of solution for roadside?

  ☐ yes √ no

Please, specify other system(s):

.....

.....

.....

- Which other solution(s) do you use in tunnel?

.....

.....

- Which other solution(s) do you use on bridge?

.....

.....

- Which other solution(s) do you use in cutting?

.....

.....

- Which other solution(s) do you use on embankment?

.....

.....

- Which kind of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	√	√	√	√
Horizontal sign	√	√	√	√
Vertical sign	√	√	√	√
Fences	√	√	√	√
Walls	☐	☐	☐	☐
Other	☐	☐	☐	☐

2. Assessment of implemented interventions

➢ How do you assess every intervention implemented in your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	√	☐
Investment costs	☐	☐	√	☐	☐
Maintenance costs	☐	☐	√	☐	☐
Easy to use (assembly and maintenance)	☐	☐	√	☐	☐
Versatility	☐	☐	√	☐	☐

Comments:

.....

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	√	☐
Investment costs	☐	☐	√	☐	☐
Maintenance costs	☐	☐	√	☐	☐
Easy to use (assembly and maintenance)	☐	☐	√	☐	☐
Versatility	☐	☐	√	☐	☐

Comments:

.....

Vertical sign	1	2	3	4	5
Road safety	☐	☐	☐	√	☐
Investment costs	☐	☐	√	☐	☐
Maintenance costs	☐	☐	√	☐	☐
Easy to use (assembly and maintenance)	☐	☐	√	☐	☐
Versatility	☐	☐	√	☐	☐

Comments:

.....

Fences	1	2	3	4	5
Road safety	☐	☐	☐	√	☐
Investment costs	☐	☐	√	☐	☐
Maintenance costs	☐	☐	√	☐	☐
Easy to use (assembly and maintenance)	☐	☐	√	☐	☐
Versatility	☐	☐	√	☐	☐

Comments:

.....

Walls	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

Other (specify)	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

.....

- How do you estimate safety performance? Do you use data of accidents?

  √ yes ☐ no

- Do you use an accident rate?

  √ yes ☐ no

- Which kind of rate is it? √ mortality rate
  √ injury rate
  ☐ global rate

Please, explain your evaluation method: $AK = \frac{A \cdot 10^6}{365 \cdot N \cdot L \cdot m}$

A – number of accidents happened in road section for 4 years; N – annual average daily traffic veh/day; L – road section, km; m – number of years (m=4).

- Results on safety performance are available for each type of roadside intervention?
  ☐ yes √ no

3. New developments and future systems

- Are you pleased with present solutions for roadside?
  √ yes ☐ no
- Do you think it would be implemented according to new safety principles?
  √ yes ☐ no

If yes, please explain how you improved/would improve this:
change of current standards to new: change of strength class for barriers and change of using rules; remove obstacles from roadsides;

- Do you agree effectiveness of interventions should be estimate with damages to people?
  √ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:
It must be less death or serious injuries. No methodology for evaluation this now.

- Do you know breakaway poles?
  √ yes ☐ no
- Do/Would you use them on your roads?
  √ yes ☐ no

Please, explain why yes/no:
roadside marking.

- Do you know shape and slope of escarpment can improve road safety?
  √ yes ☐ no
- Do you use solution in Fig. 9?
  ☐ yes √ no
- If no, would you use it?
  √ yes ☐ no

Please, explain why yes/no:
From one of the most potentially dangerous driving manoeuvres – overtake.

Fig.9

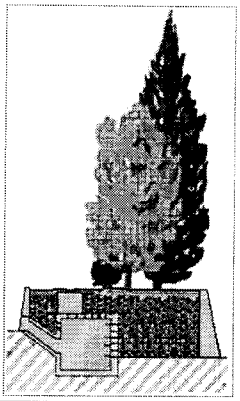


Fig.10

- Do you use solution in Fig.10 (false cutting)?

☐ yes √ no

- If no, would you use it?

☐ yes √ no

Please, explain why yes/no:

It is too expensive.

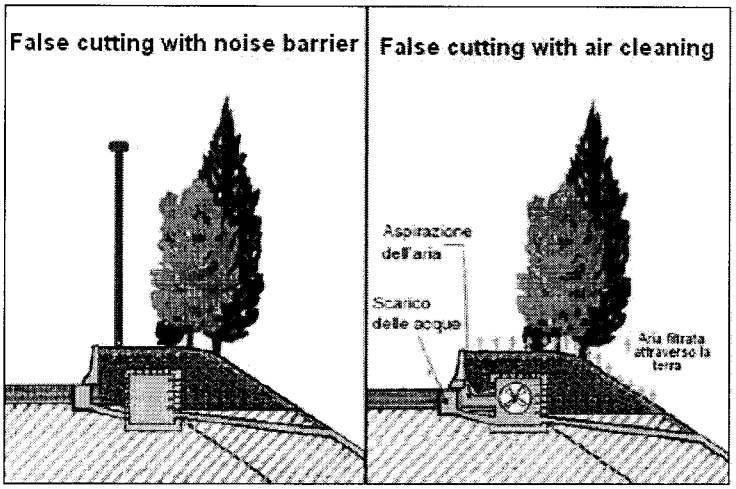


Fig.11

- Do you use solution in Fig.11 to drain water?

☐ yes √ no

- If no, would you use it?

☐ yes √ no

Please, explain why yes/no:

It is too expensive.

- Do/Would you use false cutting with noise barrier (Fig.11)?

√ yes ☐ no

Please explain why yes/no:

It is used for reduce noise.

- Do/Would you use solution in Fig.11 to clean air?

☐ yes √ no

Please explain why yes/no:

It is too expensive.

- When you combine guard rail with noise barrier, which solution do you use?

☐ Solution with concrete guard rail (Fig.12)

√ Solution with steel guard rail (Fig.13)

☐ Both, it depends on cases

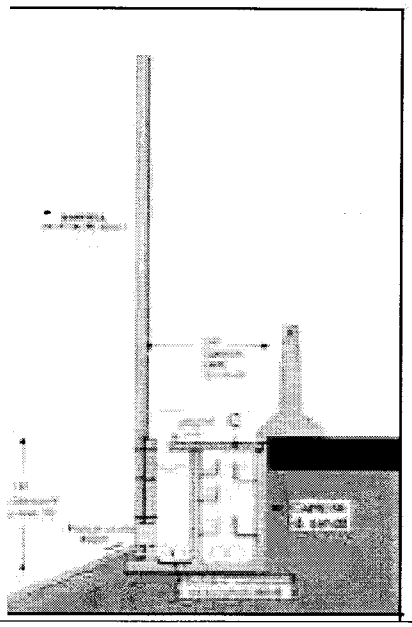


Fig.12

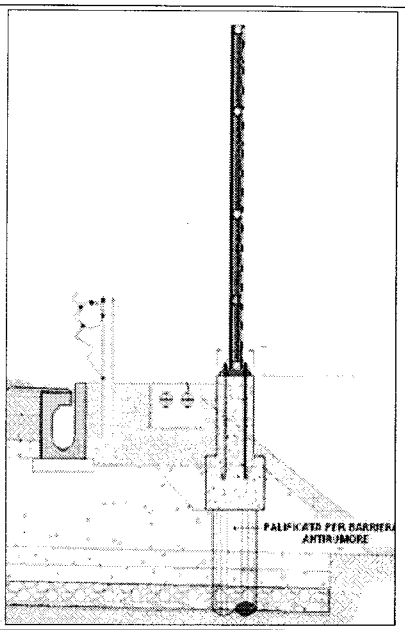


Fig.13

- Do you know rumble strips on road verge?

√ yes ☐ no

- Do/Would you use this type of intervention?

√ yes ☐ no

Please, explain why yes/no:

1) to attract attention
2) roadside couldn't be used for driving

- Which other new roadside intervention do you know? Please, give a short description.

- Which system(s) would you prefer using and why?

Steel guard rails, *steel guard rails* prevent truck collisions, protecting people, property, and equipment from harm.

- Which system(s), in your opinion, will be the most used in the future and why?

Cleaning of obstacles roadsides;

Use of steel guard rails;

Use of rumble strips;

Use of vertical and horizontal marking.

Thanks for answering our questionnaire. If you wish, we will provide you final results of our survey.

We would be very glad to get final results of survey.

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- How you assess interventions
- New solutions for roadsides

1. General questions:

- Country Luxembourg
- Length of rural network for which the National Road Authority is responsible:

  Total network [km]: ± 5978

  Motorways [km]: 158

  Highways (dual carriageway) [km]:

  Highways (single carriageway) [km]: 798 + 2022

  Others [km]: ± 3000 rural roads

2. Roadside treatments:

- Roadsides protected with safety barriers (approximately):

  Motorways [%]: 90

  Highways (dual carriageway) [%]:

  Highways (single carriageway) [%]: 10

  Others [%]: 5

- Type of roadsides: choose a value between 1 and 5 to evaluate how often they are protected with safety barriers (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☒	☐	☐	☐
Cutting	☐	☐	☒	☐	☐
Bridge roadside	☐	☐	☐	☒	☐
Tunnel roadside	☐	☐	☒	☐	☐

Please return completed questionnaires to: francesca.latorre@unifi.it

1. **Slopes:**

- Do you consider the slope of the embankment as a factor to identify the potential safety hazard of the roadside element?

☒ yes ☐ no

- Which is the reference standard/procedure for calculation?

RPS

2. **Safety zone:**

- Do you define a safety zone outside of which hazards do not need to be protected/delineated?

☒ yes ☐ no

- Which is the reference standard/procedure for calculation?

RPS

- Do you consider shoulders as part of the safety zone?

☒ yes ☐ no

- If you use safety zone, what criteria do you use to choose between safety zone or safety barrier?

RPS

3. **Horizontal signs (markings):**

- Do you use special horizontal markings (e.g. rumble strips) on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	☐

4. Vertical signs:

- Do you use roadside delineation to highlight the road edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	☐

5. Other:

- Do you use other types of solution for protecting obstacles or delineating the roadside where there are hazards?

  ☒ yes ☐ no

  Please, specify other system(s):

  Repetition of signs along the road, automatic detection signs “danger” with flashs

- Which other solution(s) do you use in tunnels?

  LED light as guidelines on the side way

- Which other solution(s) do you use on bridges?

  Curbstones

- Which other solution(s) do you use for cuttings?

  None

- Which other solution(s) do you use on embankments?

  None

- Which type of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☒	☐	☐	☐
Steel guard rails	☒	☒	☐	☒
Wire rope barriers	☐	☐	☐	☐
Horizontal sign	☒	☐	☐	☐
Delineation	☐	☐	☐	☐
Other (specify)	☐	☐	☐	☐

3. Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☒	☐	☐
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☐	☐	☒	☐
Easy to use (assembly and maintenance)	☒	☐	☐	☐	☐
Versatility	☒	☐	☐	☐	☐

Comments:

……

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☒	☐	☐
Maintenance costs	☐	☐	☒	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☒	☐	☐

Comments:

……

Wire rope barriers	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

N/A in Luxembourg

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☒	☐	☐	☐
Maintenance costs	☐	☐	☐	☒	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☐	☐	☐

Comments:

……

Delineation	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

N/A

Other (specify)……..	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

N/A

- How do you assess safety performance? Do you use accident data?

  ☒ yes ☐ no

- Do you use an accident rate per traffic flow (e.g. per billion vehicle x km)?

  ☐ yes ☒ no

- If yes, Which kind of rate is it? ☐ mortality rate (fatalities)

  ☐ injury rate (injured casualties)

  ☐ global rate

Please explain your evaluation method:

……

……

……

- Are results on safety performance available for each type of roadside intervention?

  ☐ yes ☒ no

4. New developments and future systems

- Are you satisfied with present treatments for roadside hazards?

☒ yes ☐ no

- Do you think that adopting new safety principles would improve the situation?

☐ yes ☒ no

If yes, please explain how you improved/would improve this:

……
……
……

- Do you agree that the effectiveness of interventions should be estimated according to casualty numbers and severity of injury?

☒ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

Intervention depending on the severity of the damage

- Do you know of breakaway poles/lattix posts/breakaway lighting columns or other frangible devices?

☒ yes ☐ no

- Do/Would you use them on your roads?

☒ yes ☐ no

Please, explain why yes/no:

……
……
……

- Do you know that a change in the shape and slope of embankment slides can improve road safety?

☒ yes ☐ no

- Do you use an unpaved shoulder (see Fig. 9)?

☒ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

……

……

……

Fig.9

- Do you use false cutting (see Fig.10)?

☒ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

Architectonical reason

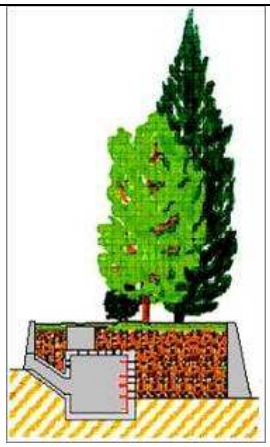


Fig.10

- Are you aware of shoulder rumble strips (see Fig. 14)?

☐ yes ☒ no

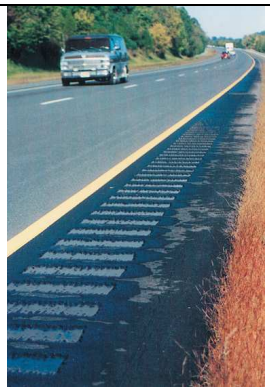


Fig.14

- Do/Would you use this type of intervention?

☐ yes ☒ no

Please, explain why yes/no and give a description of the type of shoulder rumble strip measure used:

No experience, no knowledge, no equipment

- Please give a short description of any other measure you are aware of.

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……

- Which system(s) (measure) would you prefer to use and why?

……

……

……

- Which single system (measure) do you think offers the best potential for future use and safety benefits?

……

……

……

Please return completed questionnaires to: francesca.latorre@unifi.it

QUESTIONNAIRE
ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided in three parts. The first part includes general questions about length of network and type of roadside implemented interventions. In the second part there are some questions to assess interventions mentioned in 1st part. The last part includes questions about new type of solutions to improve roadside safety.

1. General questions:

- Country: Malta
- Length of network:
  - Total network [km]: 2062
  - Motorways [km]: nil
  - Highways (single carriageway) [km]: 152
  - Highways (dual carriageway) [km]: 47
  - Others [km]: 1195 (Urban) and 668 (Rural)
- Saved with interventions on roadside (approximately):
  - Motorways [km]: Not applicable
  - Highways (single carriageway) [km]: app. 115
  - Highways (dual carriageway) [km]: app. 40
  - Others [km]: app. 330 out of 668 rural
- Type of roadsides: choose a value between 1 and 5 to evaluate how often are saved (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☒	☐	☐	☐
Cutting	☐	☒	☐	☐	☐
Bridge roadside	☐	☐	☒	☐	☐
Tunnel roadside	☐	☒	☐	☐	☐

- Which of the following systems are used on your roadsides?

1. Concrete guard rails:

☐ yes ☒ no

- Please, specify if you use it in the following roadsides:

Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment (Fig.1)	☐	☐	☐	☐	☐
Cutting (Fig.2)	☐	☐	☐	☐	☐
Bridge roadside (Fig.3)	☐	☐	☐	☐	☐
Roadside with wall (Fig.4)	☐	☐	☐	☐	☐
Tunnel roadside (Fig.4)	☐	☐	☐	☐	☐

Fig.1

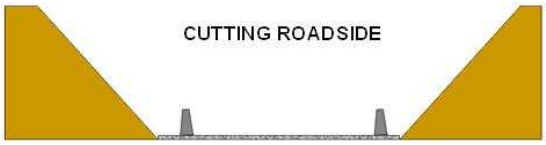


Fig.2

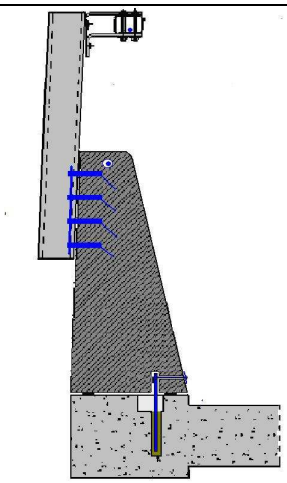


Fig.3

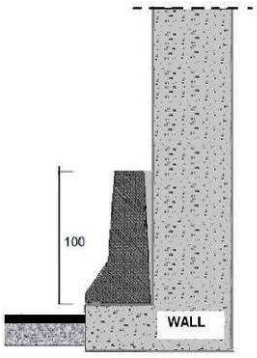


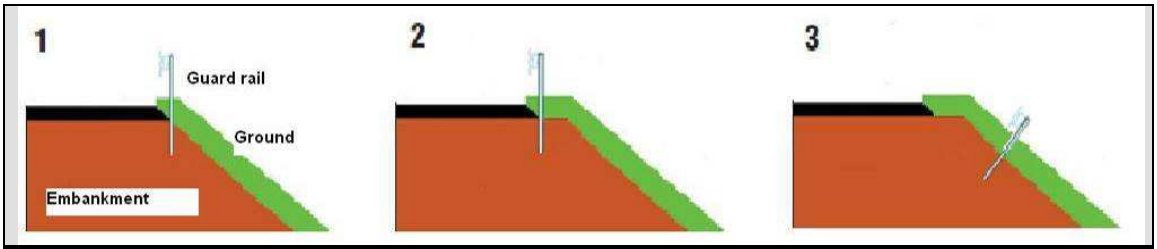
Fig.4

2. Steel guard rails:

☒ yes ☐ no

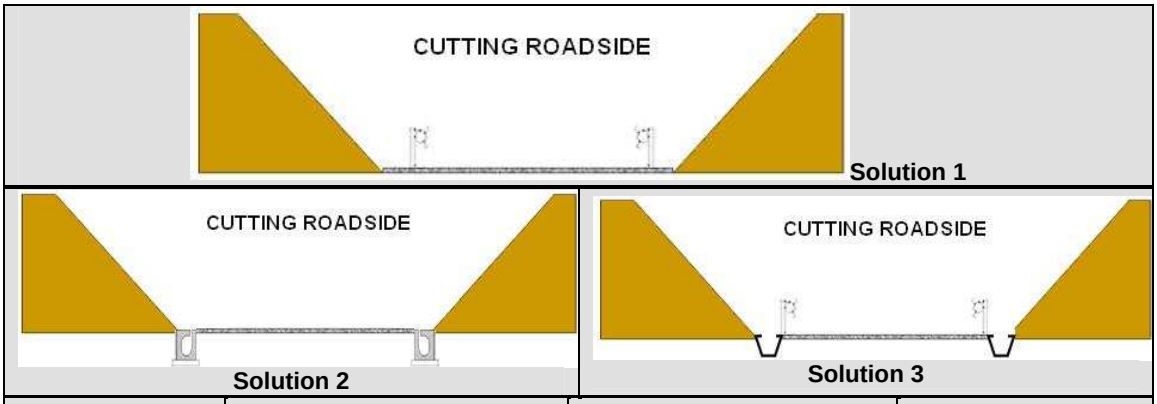
Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment	☐	☐	☐	☒	☐
Cutting	☐	☒	☐	☐	☐
Bridge roadside	☒	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☒	☐
Tunnel roadside	☐	☐	☐	☐	☒

- Embankment: looking at figure below, which kind of solution do you use?



	Solution 1	**Solution 2**	**Solution 3**
The most used	☐	☒	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	☐
Not used	☒	☐	☒

- Cutting: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	☐	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☒	☒
Not used	☒	☐	☐

3. Horizontal sign:

☒ yes ☐ no

- Do you always use horizontal sign on roadsides to highlight the edge? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☒	☐
Cutting	☐	☐	☐	☒	☐
Bridge roadside	☐	☐	☐	☐	☒
Roadside with wall	☐	☐	☐	☒	☐
Tunnel roadside	☐	☐	☐	☐	☒

- Do you use horizontal sign like shown in Fig.5?

☒ yes ☐ no

- Please explain why yes/no:

It is used to delineate the road during design stage and better guide the drivers during the operation of the road

	
Fig.5	Fig.6

4. Vertical sign:

☒ yes ☐ no

- Do you use vertical sign on roadsides to highlight edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☒	☐	☐
Cutting	☐	☐	☒	☐	☐
Bridge roadside	☐	☒	☐	☐	☐
Roadside with wall	☐	☐	☒	☐	☐
Tunnel roadside	☐	☒	☐	☐	☐

- Do you use vertical sign like example shown in Fig.6?

☒ yes ☐ no

- Please, explain why yes/no:

It is usually used in bends and to highlight road narrowing due to roadside structures……

5. Fences:

- Do you use fences on bridge roadside like Fig.7?

☐ yes ☒ no

- Is it always combined with steel guard rail?

☐ yes ☐ no Not applicable

- Please, explain if you use a different combination:

It is used only on footbridges

	
Fig.7	Fig.8

6. Walls:

- Do you use wall on roadside like Fig.8?

☒ yes ☐ no

- Choose a value between 1 and 5 to evaluate how often is used in following roadside (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☒	☐
Cutting	☐	☐	☐	☒	☐
Bridge roadside	☐	☒	☐	☐	☐

7. Other:

- Do you use other type of solution for roadside?

☐ yes ☒ no

Please, specify other system(s):

Not applicable

- Which other solution(s) do you use in tunnel?

Not applicable

- Which other solution(s) do you use on bridge?

Not applicable

- Which other solution(s) do you use in cutting?

Not applicable

- Which other solution(s) do you use on embankment?

Not applicable

- Which kind of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	☐	☒	☒	☐
Horizontal sign	☐	☒	☒	☒
Vertical sign	☐	☒	☒	☒
Fences	☐	☐	☐	☐
Walls	☐	☒	☒	☒
Other	☐	☐	☐	☐

2. Assessment of implemented interventions

➢ How do you assess every intervention implemented in your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:
Concrete guard rails are not used since in the past they required frequent interventions in terms of maintenance.

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☐	☒	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☒	☐
Versatility	☐	☐	☒	☐	☐

Comments:
……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☒	☐	☐
Maintenance costs	☐	☐	☒	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☒	☐	☐
Versatility	☐	☐	☒	☐	☐

Comments:
……

Vertical sign	1	2	3	4	5
Road safety	☐	☐	☐	☒	☐
Investment costs	☐	☐	☒	☐	☐
Maintenance costs	☐	☐	☒	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☒	☐	☐
Versatility	☐	☒	☐	☐	☐

Comments: Vertical signs are commonly used since the roadside many times consists in structures abutting with the road alignment which might not be adequately visible in absence of daylight. Otherwise, mostly common in bends in rural and other unlit roads.

Fences	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments: Fences are not used at the roadsides

Walls	1	2	3	4	5
Road safety	☐	☒	☐	☐	☐
Investment costs	☐	☐	☐	☒	☐
Maintenance costs	☐	☐	☐	☒	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☒
Versatility	☐	☐	☐	☒	☐

Comments: The walls that one can usually see at the roadsides are 500 to 1000 mm softstone walls with mortar designation iv.

Other (specify)	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments: Not applicable

……

- How do you estimate safety performance? Do you use data of accidents?

☐ yes ☒ no

- Do you use an accident rate?

☐ yes ☒ no

- Which kind of rate is it? ☐ mortality rate
  ☐ injury rate
  ☐ global rate

Please, explain your evaluation method:

- Results on safety performance are available for each type of roadside intervention?

☐ yes ☒ no

3. New developments and future systems

- Are you pleased with present solutions for roadside?

☐ yes ☒ no

- Do you think it would be implemented according to new safety principles?

☐ yes ☐ no ?

If yes, please explain how you improved/would improve this:

Does this refer to the respective country or in general?

……

……

……

- Do you agree effectiveness of interventions should be estimate with damages to people?

☐ yes ☐ no ?????

If yes, please explain how you evaluate/would evaluate this:

……

……

……

- Do you know breakaway poles?

☒ yes ☐ no

- Would you use them on your roads?

☐ yes ☒ no

Please, explain why yes/no:

In most of the cases, locally there are other activities happening on the roads other than motorists. Breakaway poles can pose a hazard to other road users.

- Do you know shape and slope of escarpment can improve road safety?

☒ yes ☐ no

- Do you use solution in Fig. 9?

☐ yes ☒ no

- If no, would you use it?

☒ yes ☐ no

Please, explain why yes/no:

We do not use mostly de to the limit of space on the roadsides.

Fig.9

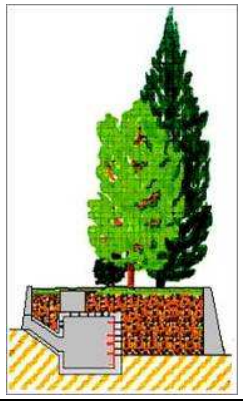


Fig.10

- Do you use solution in Fig.10 (false cutting)?

☐ yes ☒ no

- If no, would you use it?

☒ yes ☐ no

Please, explain why yes/no:

Due to the limit of space, its use has to be boldly justified by a sound business case since implementing it might mean considerable expenses in expropriating surrounding areas of land.

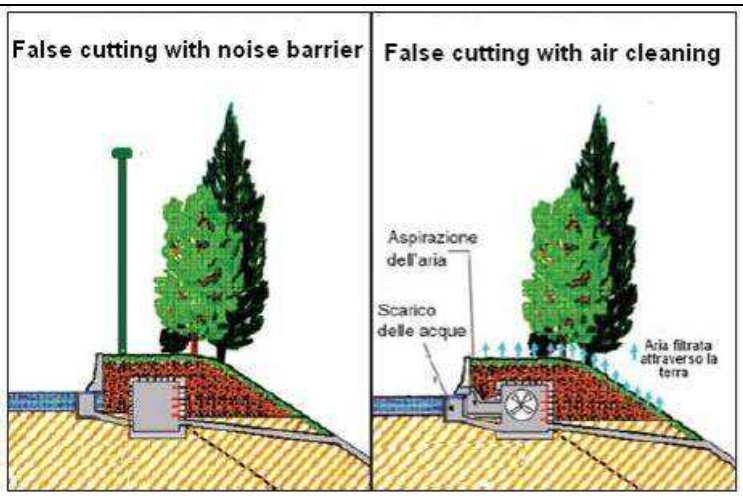


Fig.11

- Do you use solution in Fig.11 to drain water?

☒ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

Not applicable

- Do/Would you use false cutting with noise barrier (Fig.11)?

☐ yes ☒ no

Please explain why yes/no:

The false cutting can pose an issue with available space during reconstruction of existing roads.

- Do/Would you use solution in Fig.11 to clean air?

☐ yes ☒ no

Please explain why yes/no:

The false cutting can pose an issue with available space during reconstruction of existing roads.

- When you combine guard rail with noise barrier, which solution do you use?
  - ☐ Solution with concrete guard rail (Fig.12)
  - ☐ Solution with steel guard rail (Fig.13)
  - ☐ Both, it depends on cases

Presently we are not using noise barriers

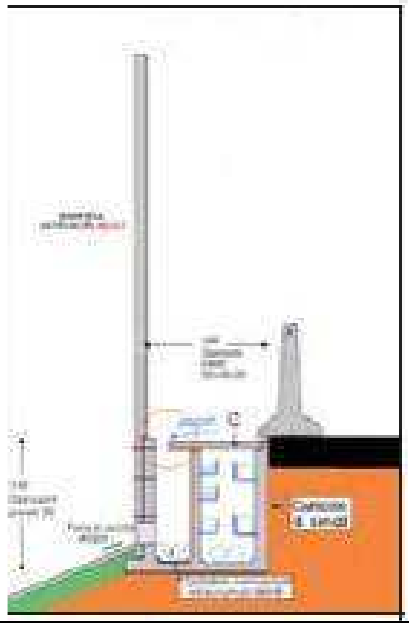


Fig.12

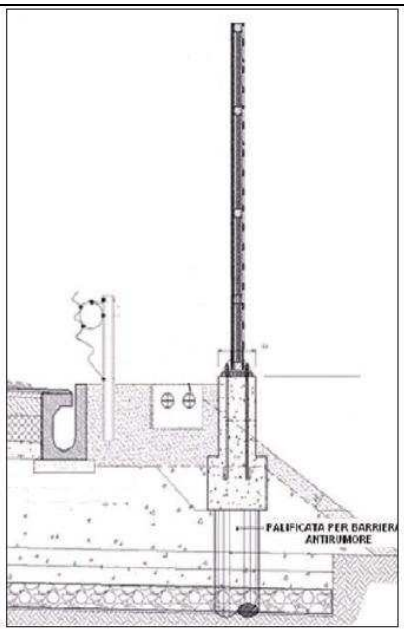


Fig.13

- Do you know rumble strips on road verge?

☒ yes ☐ no

- Would you use this type of intervention?

☒ yes ☐ no

Please, explain why yes/no:

This measure enhances road safety without taking up a lot of space, efficient to implement and is effective

- Which other new roadside intervention do you know? Please, give a short description.

……

-

- Which system(s) would you prefer using and why?

1. Steel barriers due to : a. ease of assembly, b. flexibility and versatility, c. aesthetics when compared to concrete solutions

- Which system(s), in your opinion, will be the most used in the future and why?

Solutions related to the exploitation of steel in enhancing road safety systems

Thanks for answering our questionnaire. If you wish, we will provide you final results of our survey.

QUESTIONNAIRE
ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided in three parts. The first part includes general questions about length of network and type of roadside implemented interventions. In the second part there are some questions to assess interventions mentioned in 1st part. The last part includes questions about new type of solutions to improve roadside safety.

1. General questions:

- Country: POLAND
- Length of network:
  - Total network [km]: 18 520
  - Motorways [km]: 852
  - Highways (single carriageway) [km]:
  - Highways (dual carriageway) [km]: 513
  - Others [km]: 17 155
- Saved with interventions on roadside (approximately):
  - Motorways [km]: 852
  - Highways (single carriageway) [km]:
  - Highways (dual carriageway) [km]: 513
  - Others [km]: according to needs
- Type of roadsides: choose a value between 1 and 5 to evaluate how often are saved (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	X	☐
Cutting	☐	☐	X	☐	☐
Bridge roadside	☐	X	☐	☐	☐
Tunnel roadside	X	☐	☐	☐	☐

- Which of the following systems are used on your roadsides?

1. Concrete guard rails:

☐ yes X no

- Please, specify if you use it in the following roadsides:

Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment (Fig.1)	☐	☐	☐	☐	☐
Cutting (Fig.2)	☐	☐	☐	☐	☐
Bridge roadside (Fig.3)	☐	☐	☐	☐	☐
Roadside with wall (Fig.4)	☐	☐	☐	☐	☐
Tunnel roadside (Fig.4)	☐	☐	☐	☐	☐

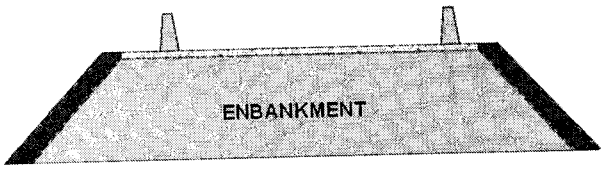


Fig.1

Fig.2

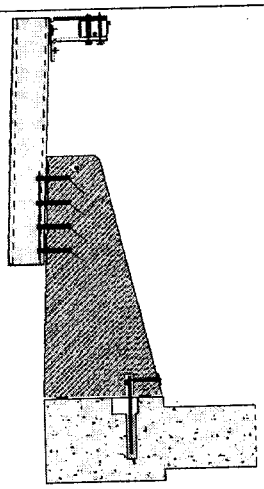


Fig.3

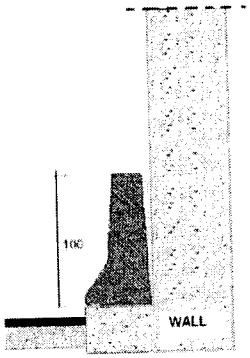


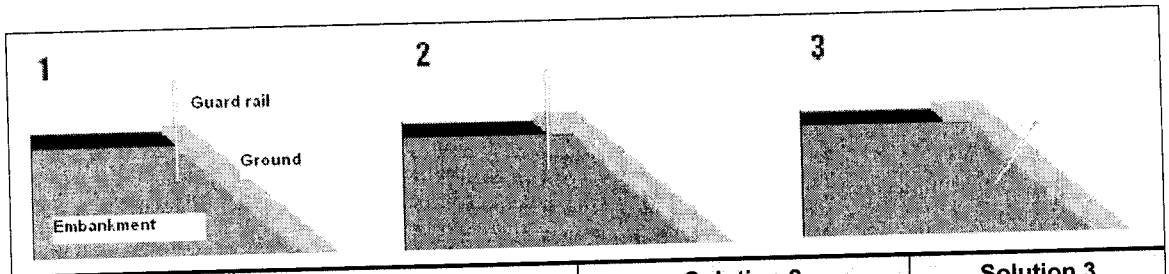
Fig.4

2. Steel guard rails:

X yes ☐ no

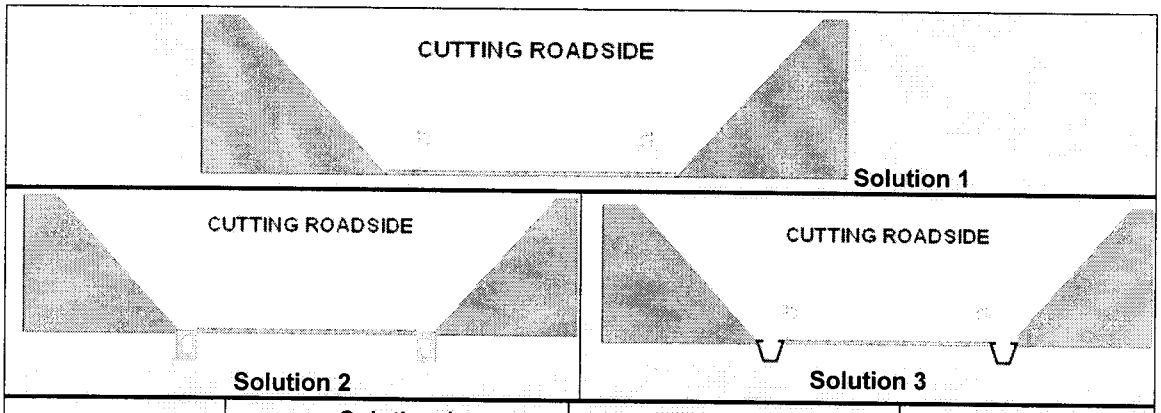
Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment	X	☐	☐	☐	☐
Cutting	☐	X	☐	☐	☐
Bridge roadside	X	☐	☐	☐	☐
Roadside with wall	☐	X	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	☐

- Embankment: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	X	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	☐
Not used	☐	☐	☐

- Cutting: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	☐	☐
The least used	☐	X	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	X
Not used	☐	☐	☐

3. Horizontal sign:

X yes ☐ no

- Do you always use horizontal sign on roadsides to highlight the edge? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	X
Cutting	☐	☐	☐	☐	X
Bridge roadside	☐	☐	☐	☐	X
Roadside with wall	☐	☐	☐	☐	X
Tunnel roadside	☐	☐	☐	☐	☐

- Do you use horizontal sign like shown in Fig.5?

X yes ☐ no

- Please explain why yes/no:

to mark area `exludet from traffic

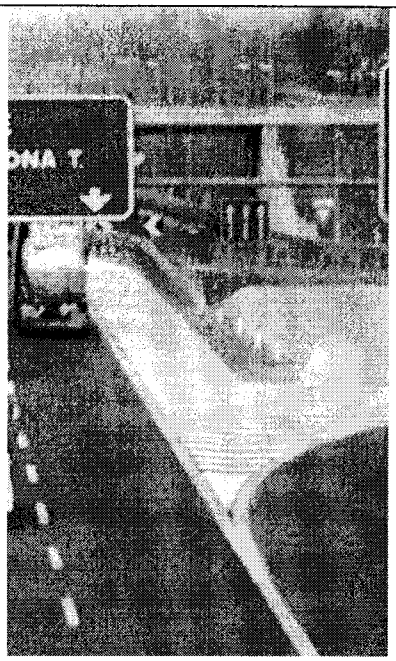


Fig.5

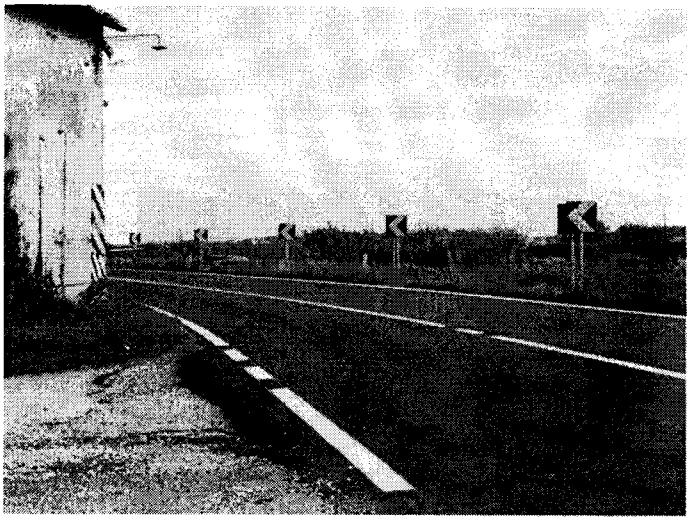


Fig.6

4. Vertical sign:

X yes ☐ no

- Do you use vertical sign on roadsides to highlight edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	X	☐
Cutting	☐	X	☐	☐	☐
Bridge roadside	☐	☐	X	☐	☐
Roadside with wall	X	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	☐

- Do you use vertical sign like example shown in Fig.6?

X yes ☐ no

- Please, explain why yes/no:

it is used on the highway ramps and to mark dangereus horizontal curve, road gauge

5. Fences:

- Do you use fences on bridge roadside like Fig.7?

X yes ☐ no

- Is it always combined with steel guard rail?

X yes ☐ no

- Please, explain if you use a different combination:

.....

.....

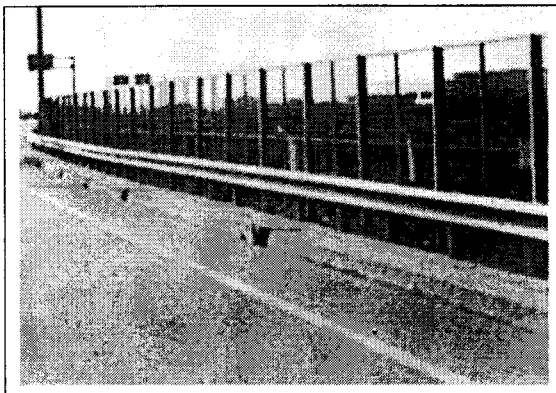


Fig.7

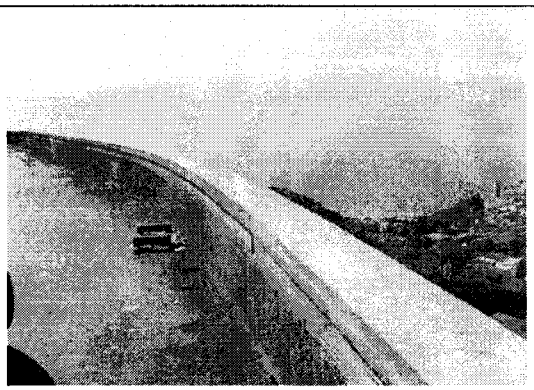


Fig.8

6. Walls:

- Do you use wall on roadside like Fig.8?

☐ yes X no

- Choose a value between 1 and 5 to evaluate how often is used in following roadside (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐

7. Other:

- Do you use other type of solution for roadside?

☐ yes X no

Please, specify other system(s):

.....

.....

.....

- Which other solution(s) do you use in tunnel?

.....

.....

- Which other solution(s) do you use on bridge?

.....

.....

- Which other solution(s) do you use in cutting?

.....

.....

- Which other solution(s) do you use on embankment?

.....

.....

- Which kind of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	X	X	X	☐
Horizontal sign	X	X	X	X
Vertical sign	X	X	X	X
Fences	X	X	X	☐
Walls	☐	☐	☐	☐
Other	☐	☐	☐	☐

2. Assessment of implemented interventions

➢ How do you assess every intervention implemented in your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	X	☐
Investment costs	☐	☐	X	☐	☐
Maintenance costs	☐	X	☐	☐	☐
Easy to use (assembly and maintenance)	☐	X	☐	☐	☐
Versatility	☐	☐	X	☐	☐

Comments:
.....

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	X	☐
Investment costs	☐	☐	☐	X	☐
Maintenance costs	☐	☐	X	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	X	☐
Versatility	☐	☐	X	☐	☐

Comments:
.....

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	X	☐	☐
Investment costs	☐	☐	☐	X	☐
Maintenance costs	☐	☐	X	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	X	☐
Versatility	☐	☐	X	☐	☐

Comments:
.....

Vertical sign	1	2	3	4	5
Road safety	☐	☐	X	☐	☐
Investment costs	☐	☐	☐	X	☐
Maintenance costs	☐	☐	X	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	X	☐
Versatility	☐	☐	X	☐	☐

Comments:
.....

Fences	1	2	3	4	5
Road safety	☐	☐	☐	X	☐
Investment costs	☐	X	☐	☐	☐
Maintenance costs	☐	X	☐	☐	☐
Easy to use (assembly and maintenance)	☐	X	☐	☐	☐
Versatility	☐	X	☐	☐	☐

Comments:
.....

Walls	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:
We don't use it.

Other (specify)	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:
.....

- How do you estimate safety performance? Do you use data of accidents?

  X yes ☐ no

- Do you use an accident rate?

  X yes ☐ no

- Which kind of rate is it? X mortality rate
  X njury rate
  X global rate

Please, explain your evaluation method:
We use following rates: number of killed per 100 accidents, number of injured per 100 accidents, accidents' density rate, number of accidents/killed/injured per 100 000 citizen, number of accidents/killed/injured per 10^8 V-km

- Results on safety performance are available for each type of roadside intervention?
  ☐ yes X no

3. New developments and future systems

- Are you pleased with present solutions for roadside?
  X yes ☐ no
- Do you think it would be implemented according to new safety principles?
  X yes ☐ no

If yes, please explain how you improved/would improve this:
.....
.....
.....

- Do you agree effectiveness of interventions should be estimate with damages to people?
  ☐ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:
.....
.....
.....

- Do you know breakaway poles?
  X yes ☐ no
- Do/Would you use them on your roads?
  X yes ☐ no

Please, explain why yes/no:
.....
.....
.....

- Do you know shape and slope of escarpment can improve road safety?
  X yes ☐ no
- Do you use solution in Fig. 9?
  ☐ yes X no
- If no, would you use it?
  X yes ☐ no

Please, explain why yes/no:

.....

.....

.....

Fig.9

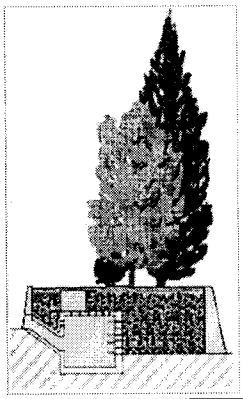


Fig.10

- Do you use solution in Fig.10 (false cutting)?

☐ yes X no

- If no, would you use it?

☐ yes X no

Please, explain why yes/no:

.....

.....

.....

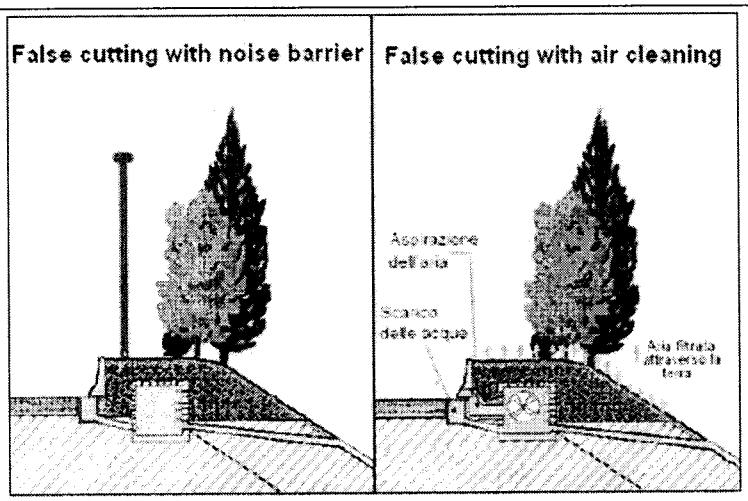


Fig.11

- Do you use solution in Fig.11 to drain water?

☐ yes X no

- If no, would you use it?

☐ yes X no

Please, explain why yes/no:

.....

.....

.....

- Do/Would you use false cutting with noise barrier (Fig.11)?

☐ yes X no

Please explain why yes/no:

.....

.....

.....

- Do/Would you use solution in Fig.11 to clean air?

☐ yes X no

Please explain why yes/no:

.....

.....

.....

- When you combine guard rail with noise barrier, which solution do you use?

☐ Solution with concrete guard rail (Fig.12)

X Solution with steel guard rail (Fig.13)

☐ Both, it depends on cases

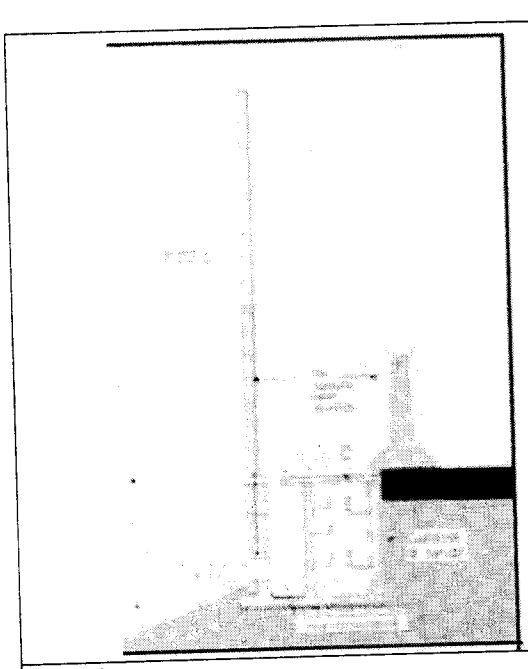


Fig.12

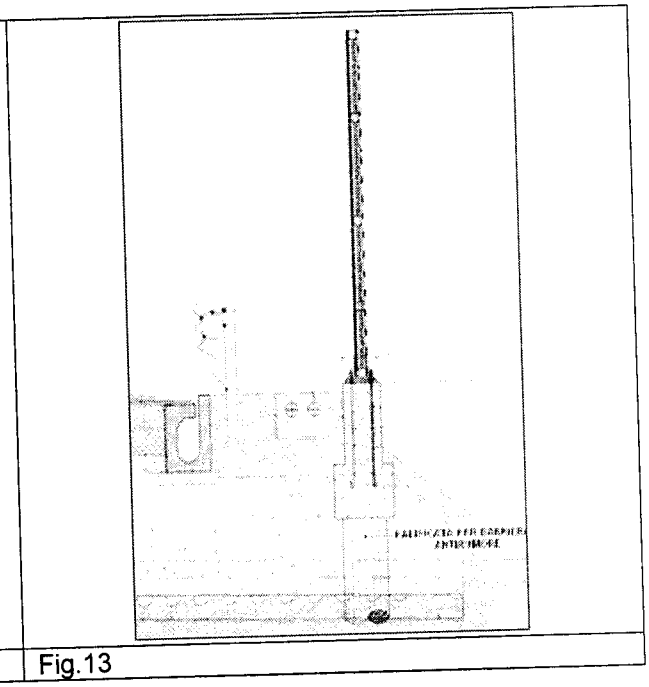


Fig.13

- Do you know rumble strips on road verge?

X yes ☐ no

- Do/Would you use this type of intervention?

X yes ☐ no

Please, explain why yes/no:

.....

.....

.....

- Which other new roadside intervention do you know? Please, give a short description.

.....

.....

.....

.....

.....

- Which system(s) would you prefer using and why?

.....

.....

.....

- Which system(s), in your opinion, will be the most used in the future and why?

.....

.....

.....

Thanks for answering our questionnaire. If you wish, we will provide you final results of our survey.

QUESTIONNAIRE
ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided in three parts. The first part includes general questions about length of network and type of roadside implemented interventions. In the second part there are some questions to assess interventions mentioned in 1st part. The last part includes questions about new type of solutions to improve roadside safety.

1. General questions:

- Country Slovenia
- Length of network:
  - Total network [km]: 38.712 State & Municipality roads
  - Motorways [km]: 696 State roads (DARS)
  - Highways (single carriageway) [km]: 5.956 State roads (Agency for roads)
  - Highways (dual carriageway) [km]: ……..
  - Others [km]: 38.712 Municipality roads
- Saved with interventions on roadside (approximately):
  - Motorways [km]: ……..
  - Highways (single carriageway) [km]: ……..
  - Highways (dual carriageway) [km]: ……..
  - Others [km]: ……..
- Type of roadsides: choose a value between 1 and 5 to evaluate how often are saved (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	X	☐
Cutting	☐	☐	☐	X	☐
Bridge roadside	☐	☐	X	☐	☐
Tunnel roadside	☐	☐	X	☐	☐

- Which of the following systems are used on your roadsides?

1. Concrete guard rails:

X yes ☐ no

- Please, specify if you use it in the following roadsides:

Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment (Fig.1)	☐	☐	☐	X	☐
Cutting (Fig.2)	☐	☐	☐	☐	X
Bridge roadside (Fig.3)	X	☐	☐	☐	☐
Roadside with wall (Fig.4)	X	☐	☐	☐	☐
Tunnel roadside (Fig.4)	☐	☐	☐	☐	X

Fig.1

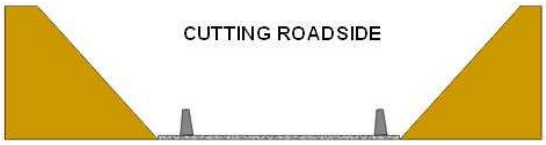


Fig.2

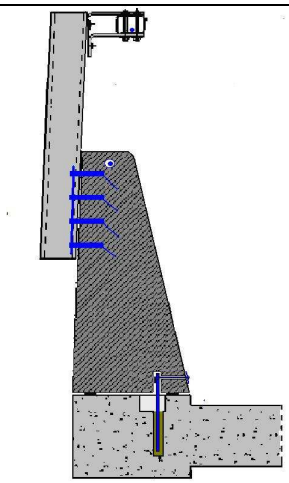


Fig.3

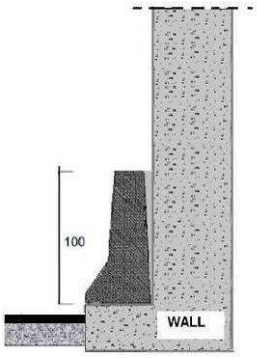


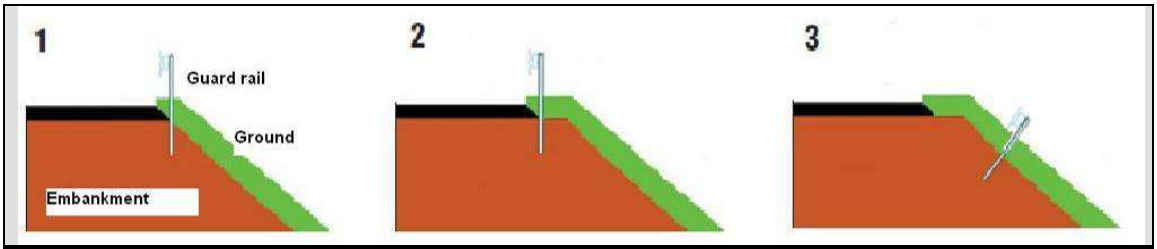
Fig.4

2. Steel guard rails:

X yes ☐ no

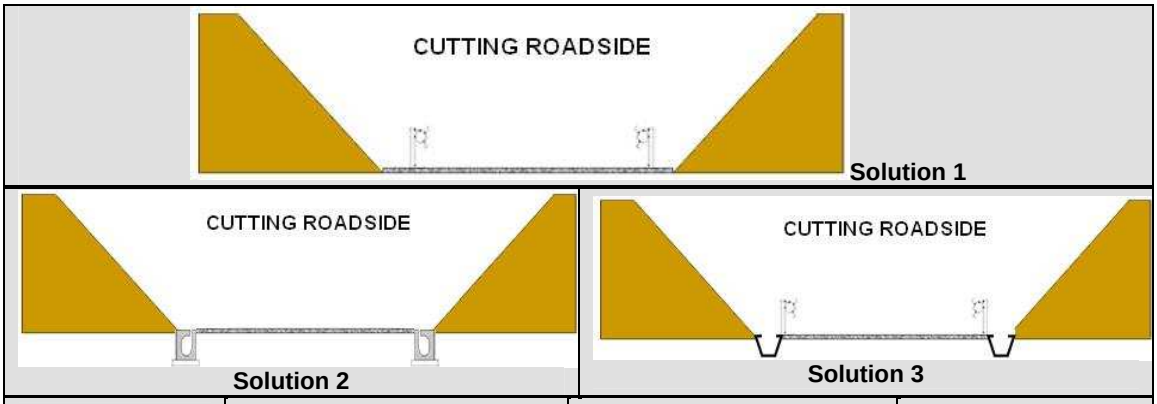
Type of roadside	The most used	The least used	Experimental	Occasionally used	Not used
Embankment	X	☐	☐	☐	☐
Cutting	☐	☐	☐	X	☐
Bridge roadside	X	☐	☐	☐	☐
Roadside with wall	X	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	X

- Embankment: looking at figure below, which kind of solution do you use?



	Solution 1	**Solution 2**	**Solution 3**
The most used	**X**	**X**	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	☐
Not used	☐	☐	**X**

- Cutting: looking at figure below, which kind of solution do you use?



	Solution 1	Solution 2	Solution 3
The most used	☐	**X**	☐
The least used	☐	☐	☐
Experimental	☐	☐	☐
Occasionally used	☐	☐	☐
Not used	☐	☐	☐

3. Horizontal sign:

X yes ☐ no

- Do you always use horizontal sign on roadsides to highlight the edge? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	X
Cutting	☐	☐	☐	☐	X
Bridge roadside	☐	☐	☐	☐	X
Roadside with wall	☐	☐	☐	☐	X
Tunnel roadside	☐	☐	☐	☐	X

- Do you use horizontal sign like shown in Fig.5?

X yes ☐ no

- Please explain why yes/no:

Mostly we use just the edge line, when necessary (dangerous obsicle or intersection) we use diagonal lanes as well.

Fig.5

Fig.6

4. Vertical sign:

X yes ☐ no

- Do you use vertical sign on roadsides to highlight edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	X	☐	☐
Cutting	☐	☐	X	☐	☐
Bridge roadside	☐	X	☐	☐	☐
Roadside with wall	☐	☐	X	☐	☐
Tunnel roadside	☐	X	☐	☐	☐

- Do you use vertical sign like example shown in Fig.6?

X yes ☐ no

- Please, explain why yes/no:

We use it when we have to emphasize the curve – the course of the road or obsticle beside/above it.

5. Fences:

- Do you use fences on bridge roadside like Fig.7?

X yes ☐ no

- Is it always combined with steel guard rail?

X yes ☐ no

- Please, explain if you use a different combination:

We use simillar solutions to protect the snow falling down on road under, some products are for wind protection and ofcourse for people protections. The products can be on steel or concreate barriers.

	
Fig.7	Fig.8

6. Walls:

- Do you use wall on roadside like Fig.8?

  ☐ yes X no (There are some on old roads)

- Choose a value between 1 and 5 to evaluate how often is used in following roadside (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	X	☐	☐	☐
Cutting	X	☐	☐	☐	☐
Bridge roadside	X	☐	☐	☐	☐

7. Other:

- Do you use other type of solution for roadside?

  ☐ yes X no

Please, specify other system(s):

……

……

……

- Which other solution(s) do you use in tunnel?

……

……

- Which other solution(s) do you use on bridge?

……

……

- Which other solution(s) do you use in cutting?

……

……

- Which other solution(s) do you use on embankment?

……

……

- Which kind of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	X	☐	☐	☐
Steel guard rails	X	X	☐	X
Horizontal sign	X	X	☐	X
Vertical sign	X	X	☐	X
Fences	X	X	☐	X
Walls	X	☐	☐	☐
Other	☐	☐	☐	☐

2. Assessment of implemented interventions

➢ How do you assess every intervention implemented in your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	X	☐
Investment costs	☐	☐	☐	X	☐
Maintenance costs	☐	☐	X	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	X
Versatility	☐	☐	☐	X	☐

Comments:

……

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	X	☐
Investment costs	☐	☐	X	☐	☐
Maintenance costs	☐	☐	X	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	X	☐
Versatility	☐	☐	☐	☐	X

Comments:

……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	X	☐
Investment costs	☐	☐	☐	X	☐
Maintenance costs	☐	☐	X	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	X
Versatility	☐	☐	☐	X	☐

Comments:
……

Vertical sign	1	2	3	4	5
Road safety	☐	☐	X	☐	☐
Investment costs	☐	☐	☐	X	☐
Maintenance costs	☐	☐	☐	X	☐
Easy to use (assembly and maintenance)	☐	☐	☐	X	☐
Versatility	☐	☐	☐	☐	X

Comments:
……

Fences	1	2	3	4	5
Road safety	☐	☐	X	☐	☐
Investment costs	☐	☐	☐	X	☐
Maintenance costs	☐	☐	X	☐	☐
Easy to use (assembly and maintenance)	☐	X	☐	☐	☐
Versatility	☐	☐	X	☐	☐

Comments:
……

Walls	1	2	3	4	5
Road safety	☐	☐	X	☐	☐
Investment costs	☐	X	☐	☐	☐
Maintenance costs	☐	☐	X	☐	☐
Easy to use (assembly and maintenance)	X	☐	☐	☐	☐
Versatility	☐	X	☐	☐	☐

Comments:
……

Other (specify)	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:
……

- How do you estimate safety performance? Do you use data of accidents?

  X yes ☐ no

- Do you use an accident rate?

  X yes ☐ no

- Which kind of rate is it? ☐ mortality rate
  X injury rate
  ☐ global rate

Please, explain your evaluation method: using Before-After Accidents comparison

- Results on safety performance are available for each type of roadside intervention?

  ☐ yes ☐ no

3. New developments and future systems

- Are you pleased with present solutions for roadside?

  ☐ yes X no

- Do you think it would be implemented according to new safety principles?

  X yes ☐ no

If yes, please explain how you improved/would improve this:

First there must be a general understanding and implementation of human factor concept into the road design. So that roads would be build, maintained in that vision/knowladge in mind.

- Do you agree effectiveness of interventions should be estimate with damages to people?

  X yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

Every intervention has its effect on people, by considering the human factor (perception…) as well the impact factor on human body when accident happen. The intervention should be as human friendly as possible.

- Do you know breakaway poles?

  X yes ☐ no

- Do/Would you use them on your roads?

  ☐ yes X no

Please, explain why yes/no:

It is included in proposition for modification of Technical specifications.

- Do you know shape and slope of escarpment can improve road safety?

  X yes ☐ no

- Do you use solution in Fig. 9?

  ☐ yes X no

- If no, would you use it?

X yes ☐ no

Please, explain why yes/no:

There is enough space to correct the drives mistake and also too wide roads can be narrowed (speed management).

Fig.9

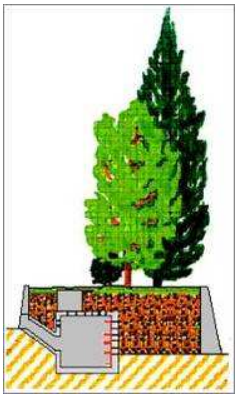


Fig.10

- Do you use solution in Fig.10 (false cutting)?

☐ yes X no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

……

……

……

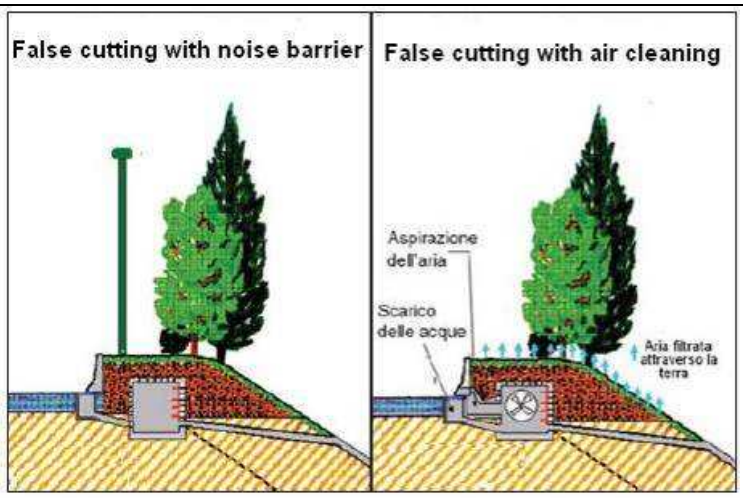


Fig.11

- Do you use solution in Fig.11 to drain water?

☐ yes X no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

……

……

……

- Do/Would you use false cutting with noise barrier (Fig.11)?

☐ yes ☐ no

Please explain why yes/no:

……

……

……

- Do/Would you use solution in Fig.11 to clean air?

☐ yes ☐ no

Please explain why yes/no:

……

……

……

- When you combine guard rail with noise barrier, which solution do you use?

☐ Solution with concrete guard rail (Fig.12)

☐ Solution with steel guard rail (Fig.13)

X ***Both, it depends on cases***

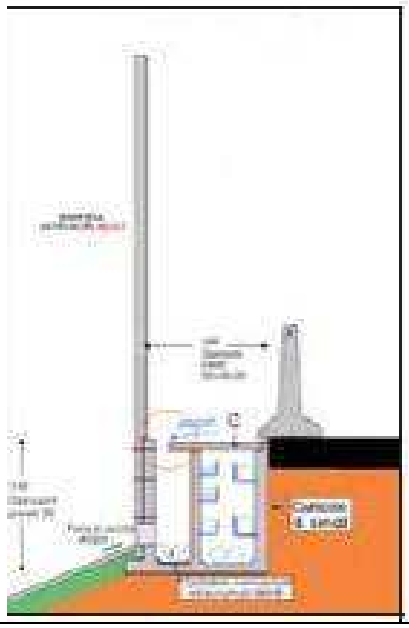


Fig.12

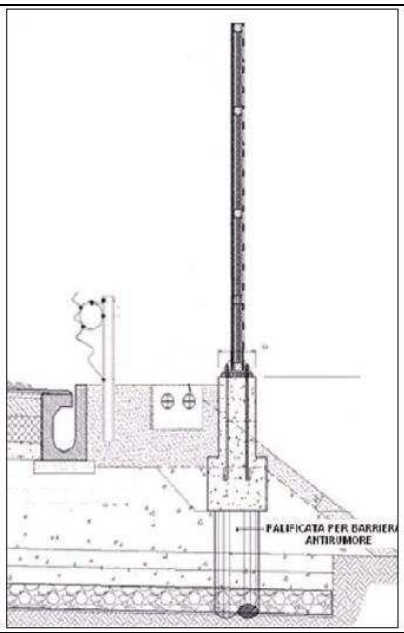


Fig.13

- Do you know rumble strips on road verge?

X yes ☐ no

- Do/Would you use this type of intervention?

X yes ☐ no

Please, explain why yes/no:

To alert drivers when crossing the edge or center line.

- Which other new roadside intervention do you know? Please, give a short description.

……

……

……

……

……

- Which system(s) would you prefer using and why?

……

……

……

- Which system(s), in your opinion, will be the most used in the future and why?

Self explanatory and forgiving roadside, so the driver could foreseen what lies ahead and if he/she should make a mistake it could be corrected.

Thanks for answering our questionnaire. If you wish, we will provide you final results of our survey.

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- How you assess interventions
- New solutions for roadsides

1. General questions:

- Country Sweden
- Length of rural network for which the National Road Authority is responsible:

Total network [km]:	925 000 km state roads
Motorways [km]:	1600 km
Highways (dual carriageway) [km]:	0
Highways (single carriageway) [km]:	the rest
Others [km]:	2+1 barrier 2000 km

2. Roadside treatments:

- Roadsides protected with safety barriers (approximately):

Motorways [%]:	no data available but a fairly large percentage
Highways (dual carriageway) [%]:	……....
Highways (single carriageway) [%]:	very low
Others [%]:	no data but fairly high

- Type of roadsides: choose a value between 1 and 5 to evaluate how often they are protected with safety barriers (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	X☐	☐
Cutting	☐	X☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	X☐
Tunnel roadside	☐	☐	☐	☐	X☐

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1. **Slopes:**

- Do you consider the slope of the embankment as a factor to identify the potential safety hazard of the roadside element?

X☐ yes ☐ no

- Which is the reference standard/procedure for calculation?

……A combination of speed limit, road category and traffic flow……

2. **Safety zone:**

- Do you define a safety zone outside of which hazards do not need to be protected/delineated?

X☐ yes ☐ no

- Which is the reference standard/procedure for calculation?

…Speed limit, road category and traffic flow. We recommend barriers……

- Do you consider shoulders as part of the safety zone?

☐ yes ☐ no Both

- If you use safety zone, what criteria do you use to choose between safety zone or safety barrier?

……We recommend barriers in all situations but very open farming countryside……

3. **Horizontal signs (markings):**

- Do you use special horizontal markings (e.g. rumble strips) on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Common on motorways in Sweden

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	☐

Vertical signs:

- Do you use roadside delineation to highlight the road edge and obstacles? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

  We use delineator posts along all major high speed roads with with reasonable traffic flows.

Type of roadside	1	2	3	4	5
Embankment	☐	☐	☐	☐	☐
Cutting	☐	☐	☐	☐	☐
Bridge roadside	☐	☐	☐	☐	☐
Roadside with wall	☐	☐	☐	☐	☐
Tunnel roadside	☐	☐	☐	☐	☐

4. Other:

- Do you use other types of solution for protecting obstacles or delineating the roadside where there are hazards?

  ☐ yes X☐ no

  Please, specify other system(s):

  ……
  ……
  ……

- Which other solution(s) do you use in tunnels?

  …Always barriers……
  ……
  ……

- Which other solution(s) do you use on bridges?

  ……Always barriers……
  ……

- Which other solution(s) do you use for cuttings?

  ……
  ……

- Which other solution(s) do you use on embankments?

  ……
  ……

- Which type of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

  Barrier type depends on speed and traffic flow and aesthetic considerations. For rural roads:

  Steel guard rails or wire ropes with N2

  Longitudinal rumble strips are used on most motorways.

  Delineator posts are used on all roads with speed limit over 70 kph and flows over AADT 2000

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	☐	☐	☐	☐
Steel guard rails	☐	☐	☐	☐
Wire rope barriers	☐	☐	☐	☐
Horizontal sign	☐	☐	☐	☐
Delineation	☐	☐	☐	☐
Other (specify)	☐	☐	☐	☐

3. Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

…Not used on rural roads in Swden

……

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐

Versatility	☐	☐	☐	☐	☐

Comments:

……Steel and wire ropes are procured with the same functional requirement, normally N2. Wire ropes are claimed to have better safety performance within the same CEN-class, much lower investment costs and higher maintenance costs. There are a lot of opinions what is the best. The Swedish MC-association dislikes barrier in general and especially wire ropes.
……

Wire rope barriers	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:

……

Delineation	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments: …There are no Swedish studies on safety effects.
……

Other (specify)……..	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:
……

- How do you assess safety performance? Do you use accident data?

  X☐ yes ☐ no

- Do you use an accident rate per traffic flow (e.g. per billion vehicle x km)?

  ☐ yes ☐ no

- If yes, Which kind of rate is it? ☐ mortality rate (fatalities)

  ☐ injury rate (injured casualties)

  ☐ global rate

Please explain your evaluation method: ……Roadside area features are normally evaluated using different type of severity rates given a single run off accidents has occurred. We have also performed a number of full-scale tests and simulations. We also work with mortality, mortal and severe injury and all injury rates
……
……
……

- Are results on safety performance available for each type of roadside intervention?

  ☐ yes X☐ no

We have done some evaluations, see our country report from Valencia

4. New developments and future systems

- Are you satisfied with present treatments for roadside hazards?

X☐ yes ☐ no

- Do you think that adopting new safety principles would improve the situation?

X☐ yes ☐ no

If yes, please explain how you improved/would improve this:

Terminations and intersection/access designs……
……
……
……

- Do you agree that the effectiveness of interventions should be estimated according to casualty numbers and severity of injury?

X☐ yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

……
……
……

- Do you know of breakaway poles/lattix posts/breakaway lighting columns or other frangible devices?

X☐ yes ☐ no

- Do/Would you use them on your roads?

X☐ yes ☐ no

Please, explain why yes/no:

……We only use breakaway poles on new installations since 30 years……
……
……

- Do you know that a change in the shape and slope of embankment slides can improve road safety?

☐ yes ☐ no

- Do you use an unpaved shoulder (see Fig. 9)?

☐ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

Our experience challenge the idea of wide safety zones with smooth slopes. Our experience is that barriers are superior from a safety viewpoint. Verges are not used in Sweden but we have support shoulders which are not paved on most high speed roads.

……

……

……

Fig.9

- Do you use false cutting (see Fig.10)?

X☐ yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

Used on motorway medians and in roadside areas in very special situations.……

……

……

……

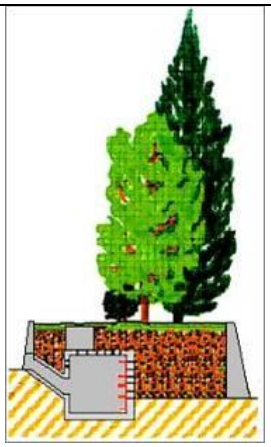

Fig.10

- Are you aware of shoulder rumble strips (see Fig. 14)?

X☐ yes ☐ no

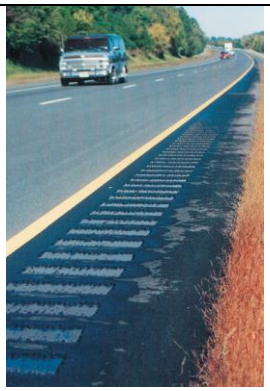

Fig.14

- Do/Would you use this type of intervention?

☐ yes ☐ no

Please, explain why yes/no and give a description of the type of shoulder rumble strip measure used:

Normally used on motorways. Single carriageway roads normally have a centre rumble strip instead……
……
……
……

- Please give a short description of any other measure you are aware of.

……
……
……
……
……

- Which system(s) (measure) would you prefer to use and why?

……
……
……

- Which single system (measure) do you think offers the best potential for future use and safety benefits?

……Barriers……
……

……

……

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire is divided into four parts:

- General questions
- Roadside treatments
- How you assess interventions
- New solutions for roadsides

1. General questions:

- Country The Netherlands
- Length of rural network for which the National Road Authority is responsible:

  Total network [km]: 3400

  Motorways [km]: 2340

  Highways (dual carriageway) [km]: 500

  Highways (single carriageway) [km]: 500

  Others [km]: ……..

2. Roadside treatments: [NOT IN MEDIANS]

- Roadsides protected with safety barriers (approximately):

  Motorways [%]: ……58…….....

  Highways (dual carriageway) [%]: ……37…….....

  Highways (single carriageway) [%]: ……16…….....

  Others [%]: ……..

- Type of roadsides: choose a value between 1 and 5 to evaluate how often they are protected with safety barriers (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	☐	☐	X	☐	☐
Cutting	☐	☐	X	☐	☐
Bridge roadside	☐	☐	☐	X	☐
Tunnel roadside	☐	X	☐	☐	☐

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1. **Slopes:**

- Do you consider the slope of the embankment as a factor to identify the potential safety hazard of the roadside element?

X yes ☐ no

- Which is the reference standard/procedure for calculation?

……

2. **Safety zone:**

- Do you define a safety zone outside of which hazards do not need to be protected/delineated?

X yes ☐ no

- Which is the reference standard/procedure for calculation?

……

- Do you consider shoulders as part of the safety zone?

X yes ☐ no

- If you use safety zone, what criteria do you use to choose between safety zone or safety barrier? *Decision Model but not available. Mostly it will be available budget and space*

……

3. **Horizontal signs (markings):**

- Do you use special horizontal markings (e.g. rumble strips) on roadsides to prevent the use of the shoulders where there are hazards close to the carriageway/ highlight the presence of an anomaly in the section? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside	1	2	3	4	5
Embankment	X	☐	☐	☐	☐
Cutting	X	☐	☐	☐	☐
Bridge roadside	X	☐	☐	☐	☐
Roadside with wall	X	☐	☐	☐	☐
Tunnel roadside	X	☐	☐	☐	☐

4. Vertical signs:

- Do you use roadside delineation to highlight the road edge [SEE TABLE 4a] and obstacles [SEE TABLE 4b]? Choose a value between 1 and 5 to evaluate how often is used (1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always):

Type of roadside 4A	1	2	3	4	5
Embankment	☐	☐	☐	☐	X
Cutting	☐	☐	☐	☐	X
Bridge roadside	☐	☐	☐	☐	X
Roadside with wall	☐	☐	☐	☐	X
Tunnel roadside	☐	☐	☐	☐	X

Type of roadside 4B	1	2	3	4	5
Embankment	X	☐	☐	☐	☐
Cutting	X	☐	☐	☐	☐
Bridge roadside	X	☐	☐	☐	☐
Roadside with wall	X	☐	☐	☐	☐
Tunnel roadside	X	☐	☐	☐	☐

5. Other:

- Do you use other types of solution for protecting obstacles or delineating the roadside where there are hazards?

☐ yes X no

Please, specify other system(s):

……
……
……

- Which other solution(s) do you use in tunnels?

……
……

- Which other solution(s) do you use on bridges?

……
……

- Which other solution(s) do you use for cuttings?

……
……

- Which other solution(s) do you use on embankments?

……

……

- Which type of interventions are used predominantly on your roads? Mark them for type of road (you can choose more than one).

Intervention	Motorway	Highways (single carriageway)	Highways (dual carriageway)	Other roads
Concrete guard rails	X	☐	☐	☐
Steel guard rails	XX	X	X	☐
Wire rope barriers	☐	☐	☐	☐
Horizontal sign	X	X	X	X
Delineation	X	X	X	X
Other (specify)	☐	☐	☐	☐

3. Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Choose a value between 1 and 5 to evaluate features below. (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Concrete guard rails	1	2	3	4	5
Road safety	☐	☐	☐	X	☐
Investment costs	☐	☐	☐	☐	X
Maintenance costs	☐	☐	☐	X	☐
Easy to use (assembly and maintenance)	☐	X	☐	☐	☐
Versatility	☐	☐	☐	☐	X

Comments:

……

Steel guard rails	1	2	3	4	5
Road safety	☐	☐	☐	X	☐
Investment costs	☐	☐	☐	X	☐
Maintenance costs	☐	☐	☐	☐	X
Easy to use (assembly and maintenance)	☐	☐	X	☐	☐
Versatility	☐	☐	☐	☐	X

Comments:

……

Wire rope barriers	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments: IT IS NOT ALLOWED TO APPLY THIS MEASURE IN THE NETHERLANDS

……

Horizontal sign	1	2	3	4	5
Road safety	☐	☐	☐	☐	X
Investment costs	X	☐	☐	☐	☐
Maintenance costs	X	☐	☐	☐	☐
Easy to use (assembly and maintenance)	X	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	X

Comments:

……

Delineation	1	2	3	4	5
Road safety	☐	☐	☐	☐	X
Investment costs	X	☐	☐	☐	☐
Maintenance costs	X	☐	☐	☐	☐
Easy to use (assembly and maintenance)	X	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	X

Comments:ALWAYS PRESENT

……

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Other (specify)……..	1	2	3	4	5
Road safety	☐	☐	☐	☐	☐
Investment costs	☐	☐	☐	☐	☐
Maintenance costs	☐	☐	☐	☐	☐
Easy to use (assembly and maintenance)	☐	☐	☐	☐	☐
Versatility	☐	☐	☐	☐	☐

Comments:
……

- How do you assess safety performance? Do you use accident data?

  X yes ☐ no

- Do you use an accident rate per traffic flow (e.g. per billion vehicle x km)?

  X yes ☐ no

- If yes, Which kind of rate is it? X mortality rate (fatalities)

  X injury rate (injured casualties)

  ☐ global rate

Please explain your evaluation method: To choose the location to analyze we use accident rate per traffic flow; the Guidelines don't make use of accident rate per traffic flow

……
……
……

- Are results on safety performance available for each type of roadside intervention?

  ☐ yes X no

4. New developments and future systems

- Are you satisfied with present treatments for roadside hazards?

☐ yes X no

- Do you think that adopting new safety principles would improve the situation?

X yes ☐ no

If yes, please explain how you improved/would improve this: DETAILED LIST OF MEASURES AND THE EFFECTIVENESS OF THESE MEASURES

……
……
……

- Do you agree that the effectiveness of interventions should be estimated according to casualty numbers and severity of injury?

X yes ☐ no

If yes, please explain how you evaluate/would evaluate this:

SEE ANSWER ABOVE

- Do you know of breakaway poles/lattix posts/breakaway lighting columns or other frangible devices?

X yes ☐ no

- Do/Would you use them on your roads?

X yes ☐ no

Please, explain why yes/no:

……
……
……

- Do you know that a change in the shape and slope of embankment slides can improve road safety?

X yes ☐ no

- Do you use an unpaved shoulder (see Fig. 9)?

X yes ☐ no

- If no, would you use it?

☐ yes ☐ no

Please, explain why yes/no:

……

……

……

Fig.9

- Do you use false cutting (see Fig.10)?

☐ yes X no

- If no, would you use it?

☐ yes X no

Please, explain why yes/no: UNCLEAR QUESTION

……

……

……

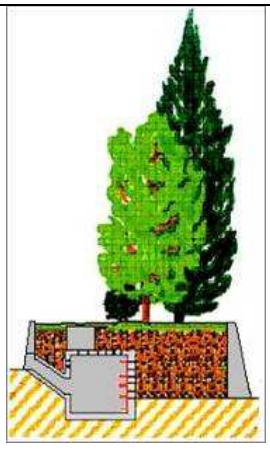

Fig.10

- Are you aware of shoulder rumble strips (see Fig. 14)?

X yes ☐ no

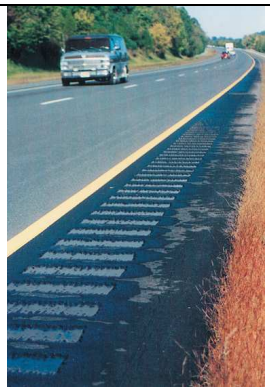

Fig.14

- Do/Would you use this type of intervention?

☐ yes X no

Please, explain why yes/no and give a description of the type of shoulder rumble strip measure used:

……

……

……

- Please give a short description of any other measure you are aware of.

……

……

……

……

……

- Which system(s) (measure) would you prefer to use and why?

……

……

……

- Which single system (measure) do you think offers the best potential for future use and safety benefits?

……

……

……

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