IRDES - Proceedings of the first webinar

IRDES

Proceedings of the first webinar

Deliverable Nr 5.1

May 2011

Università degli Studi di Firenze (UNIFI, Project Coordinator)

ÖFPZ Arsenal GmbH (AIT)

Chalmers University of Technology (CHALMERS)

ANAS S.p.A. (ANAS)

Institut français des sciences et technologies des transports, de l'aménagement et des réseaux (IFSTTAR)

This project was initiated by ERA-NET ROAD.

Project Nr. 823176
Project acronym: IRDES
Project title:
Improving Roadside Design to Forgive Human Errors

Deliverable Nr 5.1 – Proceedings of the webinar

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Version: 1.1

Executive summary

Short for ***web**-based sem**inar***, a webinar is a workshop that is transmitted over the web.

The webinar was aimed at presenting the deliverables of the IRDES Project and also to propose an interactive discussion on how to optimise the further development of the IRDES **Roadside Design Guide**, in line with stakeholders' expectations. It was opened to road laboratories, authorities, operators (including toll motorway operators) and owners, road users (fleet operators), and governmental organisations that are dealing with forgiving roadsides.

Speakers were in the same place (in Paris) while the attendees participated from their own offices with a combined phone-web connection tool.

This document describes the webinar organization and attendees, summarises the presentations offered during the webinar and the discussion that occurred with the attendees on the different topics .

The full presentations offered at the webinar are included at the end of the document.

Table of contents

1 Introduction

The goal of the Webinar was to present first results of the project IRDES to the "potential clients": road operators and managers.

4 deliverables will be done during IRDES project:

D1: State of the art - existing treatments for the design of forgiving roadsides;

D2: Practical guide for the assessment of treatment effectiveness;

D3: New forgiving roadside design guide;

D4: European survey about roadside treatment.

In the Webinar, speakers showed presentations (cf. §4) of the D1, D2 and D4 deliverables. The presentations are uploaded in a ftp site and the link and password was sent to the attendees of the webinar. Questions on the presentations can be asked directly to the presenters (emails are included) or the IRDES coordinator (francesca.latorre@unifi.it).

2 Attendees

14 experts attended the webinar, 6 at the IFSTTAR and 8 in web connection, from 9 countries (Austria, Belgium, Greece, Iceland, Ireland, Italy, Norway, and Sweden) :

Francesca LA TORRE (University of Florence, ITALY)

Lorenzo DOMENICHINI (University of Florence, ITALY)

Yann GOYAT (IFSTTAR, FRANCE)

Helen FAGERLIND (Chalmers University of Technology, SWEDEN)

Jan MARTINSSON (Chalmers University of Technology, SWEDEN)

Eleonora CESOLINI (ANAS, ITALY)

Peter SALEH (AIT, AUSTRIA)

Roberto ARDITI (SINA, ITALY)

Harry CULLEN (National Roads Authority, IRELAND)

George YANNIS (National Technical University of Athens, GREECE)

Erik DE BISSCHOP (Agency for Roads and Traffic, BELGIUM)

Otto KLEPPE (Norwegian Public Road Administration, NORWAY)

Matteo PEZZUCCHI, (Norwegian Public Road Administration, NORWAY)

Audur Thora ARNADOTTIR (Public Roads Administration, ICELAND)

3 Agenda

9:30-9:40	Welcome – introduction of participants (Francesca La Torre, UNIFI)
9:40-9:50	Overview of the IRDES project (Francesca La Torre, UNIFI)
9:50-10:05	State of the art - existing treatments for the design of forgiving roadsides (Peter Saleh, AIT)
10:05-11:00	Preliminary results from Vehicle Infrastructure Interaction Simulation (Peter Saleh, AIT)
	Preliminary results on the effectiveness of grooved rumble strips (Helen Fagerlind, CHALMERS)
	Methodology description of a “before and after treatment” study (Yann Goyat, IFSTTAR)
	Questionnaire on Forgiving Roadsides (Eleonora Cesolini, ANAS)
11:00-11:15	Break
11:15-11:30	Introduction to the interactive discussion on the guidelines (Francesca La Torre, UNIFI)
	Interactive discussion

4 Interactive presentations

4.1 Presentation n°1 : Overview of the IRDES project (Francesca La Torre, UNIFI)

An overview of the IRDES projects and its objectives was offered to the attendees to frame out the scope of the project and of the webinar.

The project is structured in 5 technical Work Packages and a coordination one (WP0) as indicated below:

WP1 – Collection and harmonization of studies and standards on roadside design [WP Leader AIT]

WP2 – Assessment of Roadside Intervention Effectiveness [WP Leader CHALMERS]

WP3 – Production of a Roadside Design Guide [UNIFI]

WP4 – European Survey [WP Leader ANAS]

WP5 – Organization of Workshops and Round Tables [WP Leader IFSTTAR]The key results of WP 1 to 4 are presented in the webinar.

4.2 Presentation n°2 : State of the art - existing treatments for the design of forgiving roadsides (Peter Saleh, AIT)

The outputs of WP1 of the IRDES project have been presented. The goal of WP1 is to collect and harmonize common standards and guidelines for roadside treatments. Initially, this deliverable introduces typical roadside hazards, which are the basis for appropriate counter-measures. The main part of this report comprises results and findings of relevant literature,

guidelines and standards dealing with roadside treatments.

Summarizing the literature study, three categories of treatments are proposed:

1. The removing or relocation of potentially dangerous roadside objects
2. The modification of roadside objects or design
3. The shielding of roadside objects

4.3 Presentation n°3 : Preliminary results from Vehicle Infrastructure Interaction Simulation (Peter Saleh, AIT)

AITs input to WP2 was presented. To analyse the necessity and effectiveness of forgiving roadside treatments, run-off-road accidents are investigated in terms of frequency and severity for the Austrian road network. Additionally, the influence of roadside objects such as trees and safety barriers on the accident severity is determined. By identifying hazardous accident locations in Austria, further typical run-off-road accidents are simulated at real existing accident black spots, using the Vehicle- Infrastructure-Interaction-Simulation (VIIS).

In simulation, various roadside designs with either single fixed roadside objects or continuous objects such as safety barriers are implemented to obtain information about their effect on safety. Indicators for the effectiveness of roadside treatments are the head injury criterion (HIC) and the abbreviated injury scale (AIS), which describe the injuries to occupants involved in collisions. Simulations show that the risk of fatal injuries strongly declines with forgiving roadside design. In future, the concept could be utilized for road safety inspections and road safety audits in order to assess safety levels.

Attendees had 3 questions about this presentation:

Questions	Answers
In the Marvin you do make the road model but how do you consider the vehicle and the roadside?	The system accounts also for the vehicle and the roadside.
In the Marvin you mean only in terms of geometry or also in terms of traffic and other factors?	All the factors can be considered in the template for defining the similar sections.
In the Marvin which is the practical output of the analysis when you simulate different roadside configurations?	1st is testing the feasibility of using the system for this type of application. 2nd evaluate the effectiveness of specific treatments by relating the AIS, HIC values to each possible solutions.

4.4 Presentation n°4 : Preliminary results on the effectiveness of grooved rumble strips (Jan Martinsson, CHALMERS)

CHALMERS input to WP2 was presented.

The effectiveness of grooved rumble strips has been evaluated in large scale by using accidents from a total of 450km motorways during 7 years. This resulted in roughly 1000 single vehicle accidents containing at least on injured occupant. Even though the final statistical calculations was not yet completed there seems to be a visible safety effect of the rumble strips but more detailed results will be presented shortly.

NOTE: in the graphs shown in pages 61 the Y axis it is the total number of single vehicle accidents per month, in page 62 it is the average number of accident averaged during 5 months, in page 63 it is the total number of single vehicle accidents per year.

Attendees had 1 question about this presentation:

Questions	Answers
Problem of rumble strips and motorcycles. A question was raised on the potential unsafety of rumble strips for motorcycle drivers	An existing study on this problematic is already available

4.5 Presentation n°5 : Methodology description of a "before and after treatment" study (Yann Goyat, IFSTTAR)

IFSTTAR input to WP2 was presented.

The before analysis of a new road treatment was presented. The goal of this study is double because first we would like to validate a measurement tool allowing to quantify impact of road treatment, and second to evaluate a new road design consisting in managing the road space by both reducing the lane width and providing wider paved shoulders.

The rangefinder system was described and first results (before works) showed.

4.6 Presentation n°6 : European survey - Questionnaire on Forgiving Roadsides (Eleonora Cesolini, ANAS)

The result of the inquiry conducted throughout Europe on the different solutions adopted for protecting roadsides has been presented. Responses to the questionnaire were received from 16 countries (Austria, Belgium, Estonia, Finland, France, Germany, Iceland, Ireland, Italy, Lithuania, Luxembourg, Malta, Poland, Slovenia, Sweden, and Netherlands) and then compared and aggregated to identify similarities and differences.

Among the key issues it appeared that the majority of the responses refer to secondary single carriageway rural roads and that the use of safety barriers as a roadside protection can be extremely different among the different countries.

The potential use of different treatments for achieving forgiving roadsides has also been investigated.

NOTE: in page 88 'ROADSIDE PROTECTED WITH SAFETY BARRIERS FOR ALL COUNTRIES' the value '0' is means 'not declare' and not '0 percent'.

4.7 Presentation n°7 : Introduction to the interactive discussion on the guidelines (Francesca La Torre, UNIFI)

For the last deliverable D3, IRDES partners asked expert attendees to propose what are

theirs needs. Based on the experience driven from existing literature and guidelines it the discussion aimed at identifying what kind of guide a road administration would like to have to really use it in practice? Most of the guides available are actually very good scientific documents rarely used in the design stage as they result to lack in practicality.

The preliminary proposed outline of the IRDES guideline is as follows:

INTRODUCTION

SECTION 1: TREATMENT/FEATURE ********

Design criteria (for different type of roads and configurations);

Assessment of effectiveness;

Case studies/Examples(?);

References divided in:

Design guidelines and standards;

Effectiveness studies

SECTION 2: TREATMENT/FEATURE ********

……..

5 Webinar discussion and suggestions

A very active discussion followed each presentation during the webinar and the attendees proposed modifications and improvements to the documents that are being prepared and specifically to the guideline structure.

The key suggestions are summarized below:

1. Include examples and case studies in the body of the document.

2. Make a clear distinction between existing roads and roads to be designed. Integrate in the process for the progressive improvement of the roads. Try to provide criteria for defining where to intervene first.

3. The problem of the balance between scientific correctness and practical applicability is always true. There is a need to have a very nice table were the user can find the different road configurations and the appropriate measures to be applied. Try to give to the practitioners answer the specific problems the he has. Lack of standards to assess safety. We have standards for design but not to assess safety.

Finally, some questions about shoulders were discussed:

- Enlarging hard shoulders can be a problem. Experiences in Ireland have shown that drivers were using the shoulder as a lane.

- Which width is ideal?

- In the introduction it has to be made clear that the road has to be forgiving and self explaining at the same time. The configuration of the roadside has an influence not only on the “forgivingness” but also the “self-explaningness”.

- Before acting in the roadside you should think about acting with different treatments that can have an effect on active safety (in the introduction).

Following the discussion the IRDES partners proposed to add a chapter in the Guideline on the overall ENRSRO1 program summarizing the other 4 projects including also the ones tackling the self-explaining roads concepts.

6 Post-webinar comments

There are a couple of post-webinar comments, which should be mentioned here to be considered in preparing the final D2 and D3 reports.

Presentation no. 4, slides on p. 62-64 ‘Preliminary results’:

Comment: Due to the length of the treated and the non treated road is different the comparison of the absolute no. of incidents is not significant and should not be used in defining the effectiveness of the treatment.

Response from the IRDES Team: The actual effectiveness evaluation in WP2 is based on a before/after evaluation and the data are shown only the have an idea of the trend of accident in time treated and in non treated sections.

Comment: As we learned from the IRDES D1 report “the median is considered as roadside”. If the question is about the percentage of roads where the roadside is protected with safety barriers in our opinion it should be distinguished between the protection of the median and the roadside on the other side of the roadway. For example, on German motorways and on highways with dual carriageways there are always safety barriers at the median. On the other side of the roadway the existence of safety barriers depends on the presence of hazards. No national database is available to answer the question how often this occurs. The same problem occurs looking at highways with a single carriageway. Due to there is no median and we don’t know where are safety barriers on the other roadside it is impossible to give a value for highways with a single carriageway for Germany.

Response from the IRDES Team: In this question the “roadside” was meant as the outer edge and not the median. It is important to highlight that some answers might have considered also the median as a roadside in the more wide sense. For Germany the slide in page 88 contains an error: it should be “0” as no data are available for the outer roadside protections (see questionnaire attached to deliverable D4).

Safety at the Heart of Road Design

Cross-border funded Joint Research Programme

IRDES

Improving Roadside Design to Forgive Human Errors

PLAN

Presentation n°1 :	Overview of the IRDES project (Francesca La Torre, UNIFI)
Presentation n°2 :	State of the art - existing treatments for the design of forgiving roadsides (Peter Saleh, AIT)
Presentation n°3 :	Preliminary results from Vehicle Infrastructure Interaction Simulation (Peter Saleh, AIT)
Presentation n°4 :	Preliminary results on the effectiveness of grooved rumble strips (Jan Martinsson, CHALMERS)
Presentation n°5 :	Methodology description of a “before and after treatment” study (Yann Goyat, IFSTTAR)
Presentation n°6 :	European survey - Questionnaire on Forgiving Roadsides (Eleonora Cesolini, ANAS)
Presentation n°7 :	Introduction to the interactive discussion on the guidelines (Francesca La Torre, UNIFI)

Safety at the Heart of Road Design

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PRESENTATION N°1

Overview of the IRDES project

(Francesca La Torre, UNIFI : francesca.latorre@unifi.it)

AGENDA

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	Interactive discussion

cross-border funded joint research programme

"ENR SRO1 – Safety at the Heart of Road Design"

"Safety at the Heart of Road Design" is a trans-national joint research programme that was initiated by "ERA-NET ROAD – Coordination and Implementation of Road Research in Europe" (ENR), a Coordination Action in the 6th Framework Programme of the EC. The funding partners of this cross-border funded Joint Research Programme are the National Road Administrations (NRA) of Austria, Belgium, Finland, Hungary, Germany, Ireland, Netherlands, Norway, Slovenia, Sweden and United Kingdom.

The IRDES Team

UNIFI: F. La Torre, L. Domenichini, A. Mercaldo

ARSENAL (now AIT): P. Saleh, P. Nitsche

CHALMERS: H. Fagerlind, S. Othman, J. Martinsson

ANAS: E. Cesolini, G. Magarò, B. Rubino, R. Grecco

LCPC (now IFSTTAR): Y. Goyat, F. Menant

The IRDES Project

The aim of the IRDES project is to produce two outputs with specific reference to a well identified set of roadside features.

- A practical and uniform guideline that allows the road designer to improve the forgivingness of the roadside;
- A practical tool for assessing (in a quantitative manner) the effectiveness of applying a given roadside treatment.

Outline of the activities

WP0 – Coordination and Management [WP Leader UNIFI]

WP1 – Collection and harmonization of studies and standards on roadside design [WP Leader AIT] ***Duration 12 Months – Start month 1***

WP2 – Assessment of Roadside Intervention Effectiveness [WP Leader CHALMERS] ***Duration 12 Months – Start month 6***

WP3 – Production of a Roadside Design Guide [UNIFI] ***Duration 12 Months – Start month 12***

WP4 – European Survey [WP Leader ANAS] ***Duration 6 Months – Start month 3 (1)***

WP5 – Organization of Workshops and Round Tables [WP Leader IFSTTAR] ***Duration 18 Months – Start month 6***

Outline of the activities

		RESP	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
WP0	Coordination and Management	UNIFI																								
WP1	Collection and harmonization of studies and standards	AIT																								
WP2	Assessment of Roadside Intervention Effectiveness	CHALMERS																								
WP3	Production of a Roadside Design Guide	UNIFI																								
WP4	European Survey	ANAS																								
WP5	Organization of Workshops and Round Tables	IFSTTAR																								

WP1 completed and report finalized after CEDR TG Road Safety revision

WP4 completed and DRAFT report circulated

WP2 & WP3 ongoing

Milestones

List of Milestones

Nr.	Milestones	Due date
1	Progress Report to CEDR TG on Road Safety [presentation]	Month 3-6
2	Progress Report to CEDR TG on Road Safety [presentation]	Month 9-12
3	Mid Term Assessment (completion of D1 and 1st Roundtable/Workshop; advancement of D2)	Month 12
4	RoundTable/Workshop 1	Month 12 (approx)
5	Progress Report to CEDR TG on Road Safety [presentation]	Month 15-18
6	Progress Report to CEDR TG on Road Safety [presentation]	Month 21-24
7	Project Ends	Month 24
8	RoundTable/Workshop 2	Month 24 (approx)

- Specific progress reports to PEB could be added, if required;
- Milestone 6 will depend on the combination between IRDES start date and CEDR TG on Road Safety Meetings.

Deliverables

List of Deliverables

Nr.	Deliverable Name / Report Name	Due date
D0.1	Mid Term Project Report [UNIFI]	Month 12
D0.2	Final Project Report [UNIFI]	Month 24
D1	State of the art report on existing tools for the design of forgiving roadsides [ARSENAL]	Month 12
D2	Practical Guide for the Assessment of Treatment Effectiveness [CHALMERS]	Month 18
D3	Forgiving Roadside Design Guide [UNIFI]	Month 24
D4	Final report on the Survey [ANAS]	Month 9
D5.1	Proceedings of RoundTable/Workshop 1 [LCPC]	Month 12 (approx)
D5.2	Proceedings of RoundTable/Workshop 2 [LCPC]	Month 24 (approx)

D0.0 Monitoring Progress Report 30.10.2009 (start)
D0.1_b Monitoring Progress Report 31.3.2009 (Month 6)

The IRDES in figures

Total Budget: EUR 267.713,00

Total man power: 33.8 man months

Duration: 15/09/2009 – 15/09/2011

Kick off Meeting in Rome: 22/09/2009

www.irdes-eranet.eu

www.irdes-eranet.eu

THE AIM OF THE WEBINAR

The webinar aims to present deliverables of IRDES and also to propose an interactive discussion to optimise the further development of the IRDES **Roadside Design Guide**, in line with stakeholders' expectations.

How would you like the IRDES Roadside Design Guide to be structured in order to be useful in practical applications by your road administration?

FINAL ENRO1 WORKSHOP

ERANET is planning to have a workshop where the results of all the 5 projects funded within the ENRO1 programme are presented

Beginning of 2012?

http://www.eranetroad.org/

Safety at the Heart of Road Design

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PRESENTATION N°2

State of the art - existing treatments for the design of forgiving roadsides

(Peter Saleh, AIT : Peter.Saleh@ait.ac.at)

WP1 – Collection and harmonization of studies and standards (WP Lead: AIT)

"State-of-the-art report of existing treatments for the design of forgiving roadsides"

Deliverable Report (D1) ready in time and published on the IRDES/ENR webpage.

Report will be published in the CEDR book series!

WP1 – Collection and harmonization of studies and standards

Collection and evaluation of relevant literature, position papers, guidelines and project reports.

Harmonisation (including consideration from existing standards) in order to provide the basis to develop a practical and uniform guideline.

This WP leads to the definition of the roadside treatments to be addressed in the IRDES Guideline and for which effectiveness will be evaluated (WP2).

WP1 – Collection and harmonization of studies and standards

Objectives:

- Relevant literature, position papers, standards, guidelines and project reports have been collected.
- Overview and details on specific forgiving roadside measures.
- National guidelines summarized.
- Complete overview on all relevant norms (e.g. EN-1317).
- D1 report submitted and approved by PEB. Re-shaped for book publication.

WP1 – Collection and harmonization of studies and standards

Main classes of Treatments:

- Removing, relocating obstacles
- Modifying roadside elements
- Shielding obstacles

WP1 – Collection and harmonization of studies and standards

Università degli Studi di Firenze (UNIFI, Project Coordinator)

ÖFPZ Arsenal GmbH (AIT)

Chalmers University of Technology (CHALMERS)

Ente Nazionale per le Strade (ANAS)

Laboratoire Central des Ponts et des Chausses (LCPC)

Safety at the Heart of Road Design

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PRESENTATION N°3

Methodology description from Vehicle Infrastructure Interaction Simulation

(Peter Saleh, AIT : Peter.Saleh@ait.ac.at)

WP2 – Assessment of effectiveness of Forgiving Roadsides with VIIS

The aim of that work can be described in the following hypotheses:

- Roadside intervention in terms of forgiving roadside reduces the crashworthiness, leading to less harmful injuries and less accident costs
- There is a necessity to implement the concept of forgiving roadsides
- Simulation tools (VIIS – Vehicle Infrastructure Interaction Simulation) are useful for assessing the effectiveness of forgiving roadsides
- Assessment of cost-effectiveness of roadside intervention

WP2 – Assessment of effectiveness of Forgiving Roadsides with VIIS

To prove the hypotheses several goals have to be fulfilled, within this activity:

- Black spot analysis over the last 5 years with focus on run-off-road accidents (as basic sites for the simulation activities)
- Investigation of the accident data base in terms of correctness and availability of roadside data (MARVin analyses and RoadSTAR data)
- Simulating the vehicle behaviour on real existing road sections
- Implement several roadside measures (road restraint systems, soft and hard shoulders) in the simulation scenarios
- Assessment of effectiveness of roadside intervention
- Assessment of cost-effectiveness of roadside intervention

WP2 – Assessment of effectiveness of Forgiving Roadsides with VIIS

(Modern) tools for accidentology - Risk assessment, Simulation, etc.

- VIIS – Vehicle Infrastructure Interaction Simulation on “real” roads
  - MARVin – Model for assessing risks of road infrastructure
  - RoadSTAR – Road Surface Tester

Overview

- Idea of MARVin as basis for VIIS
- RoadSTAR – Road Condition Monitoring
- RoadSTAR – Registration of route/trace parameters
- MARVin/VIIS – Similarity Search
- VIIS – Vehicle Infrastructure Interaction Simulation
- VIIS - Results

Idea of MARVin as basis for VIIS

MARVin – Model for Assessing Risks of Road Infrastructure

Road condition (RoadSTAR*)

Linked by the location of accident (GPS)

Accident data

STATISTIK AUSTRIA
Die Informationsmanager

Idea of MARVin as basis for VIIS

MARVin – Model for Assessing Risks of Road Infrastructure

Combination of detailed information on:

- **Road Geometry** (horizontal curvature, gradient and crossfall),
- **Road Surface Condition** (skid resistance, roughness, rut depth, texture)
- and **Road Accidents**

Models with up to 50 variables!

RoadSTAR – Road condition monitoring

Pavement Management – Road Safety

- Skid Resistance
- Texture (cracks)
- Roughness
- Transverse evenness (rutting)
- Longitudinal evenness
- about 250.000 measured values/km at 60 km/h

RoadSTAR – Registration of route/trace parameters

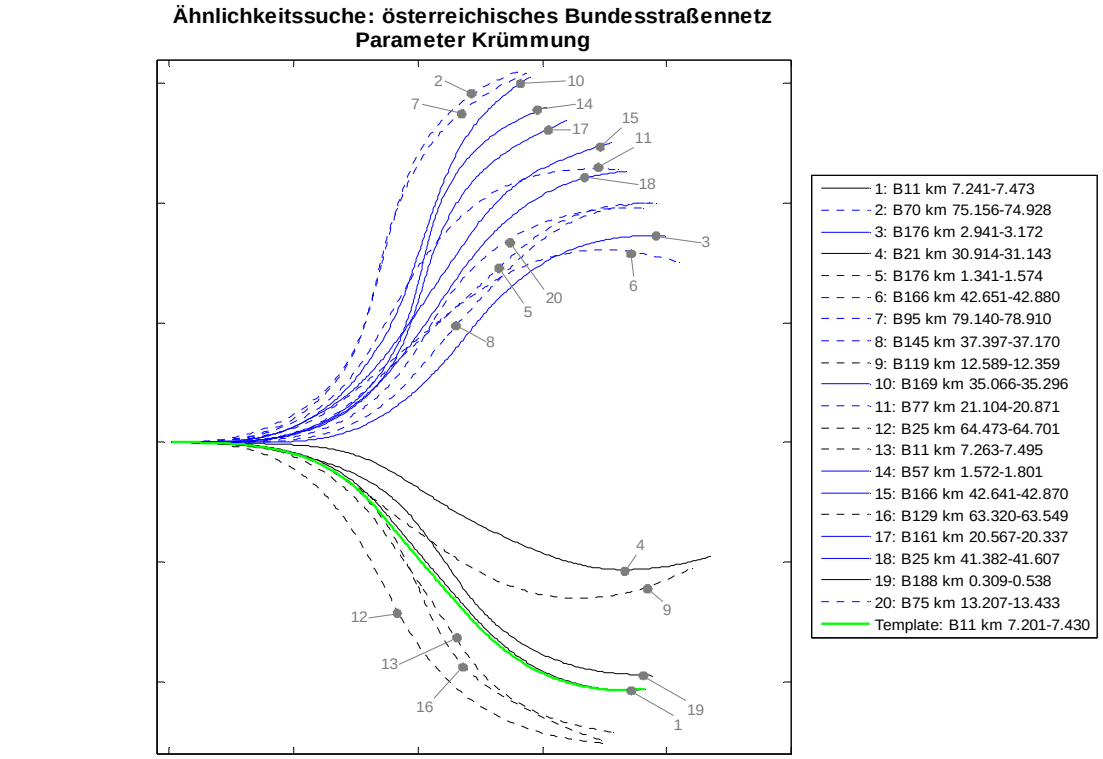
Inertial navigation gyre incl. dGPS-System

- Curve radius
- Transverse slope
- Longitudinal slope
- Actual longitudinal profile
- Registration of lane
- Creation of route graphs

Similarity Search

e.g. Finding similarities in road geometry

(simulation and search in the whole road network)

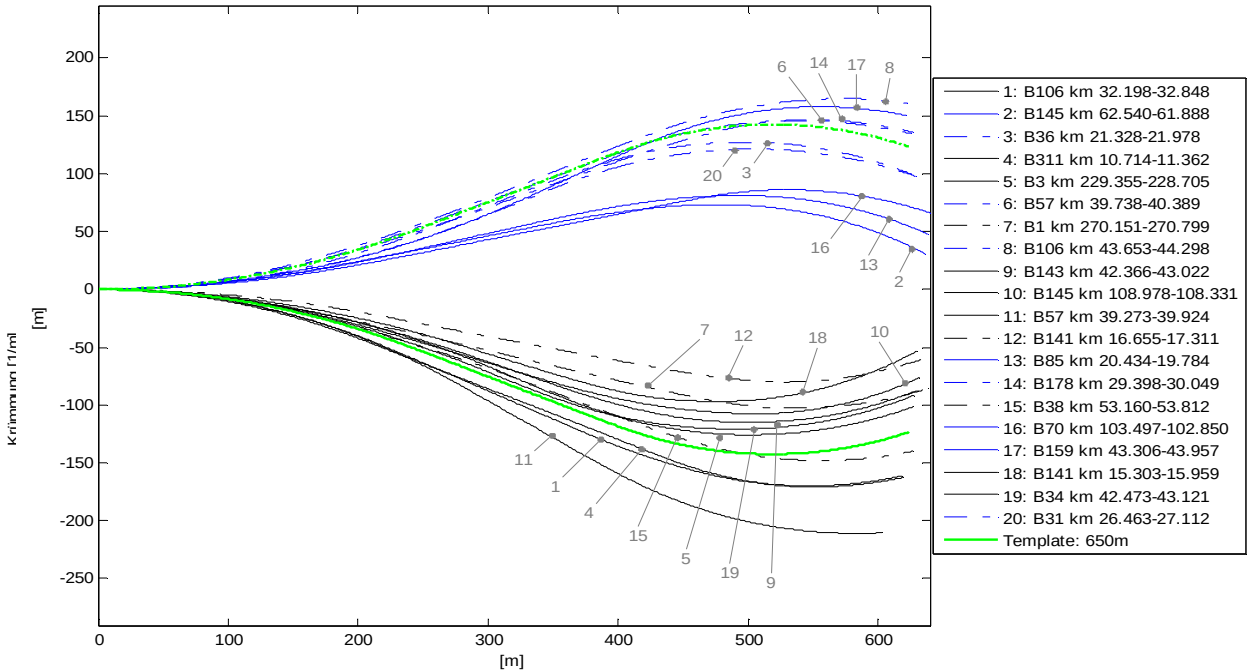


… for Road Safety Inspection

Similarity Search

e.g. Finding similarities in road geometry

(simulation and search in the whole road network)



… for Road Safety Audit

VIIS – Vehicle Infrastructure Interaction Simulation

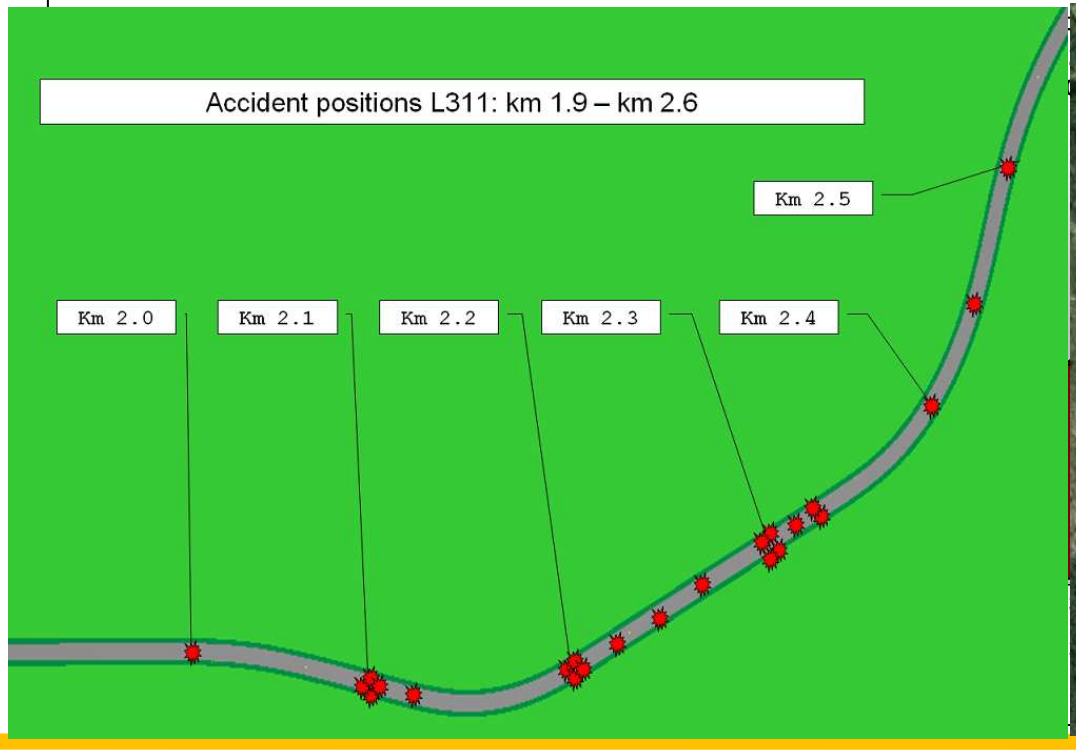
- Combination of real time vehicle dynamics simulations (PC Crash and Dymola) with road condition
- Road infrastructure data (RoadSTAR measurement data) influences on accidents – tyre/road interaction
- Simulation of accident events on „real roads“ (interface for RoadSTAR data)
- Verification of crash-causal combinations
- Verification of MARVin results/ Similarity Search

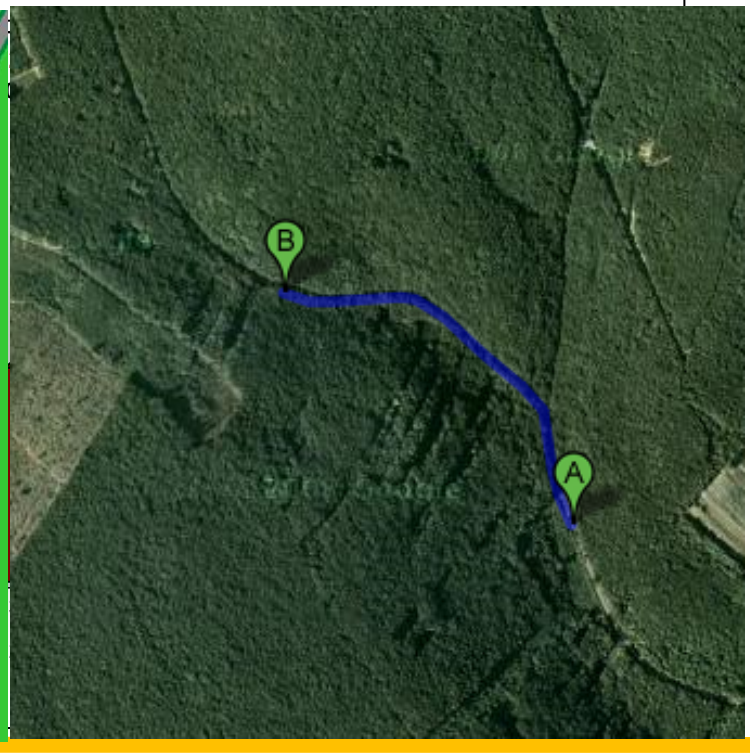
Similarity Search

- Test of the „life cycle“ of a road and its effects on road safety
- VBSA – Virtual Black Spot Analysis (Road Safety Audit), identification of potential risk factors
- Software tools for sensitivity anlaysis – Risk Assessment
- Simulation of safety treatments
- Assessment of roadside intervention effectiveness

Example (Showcase)

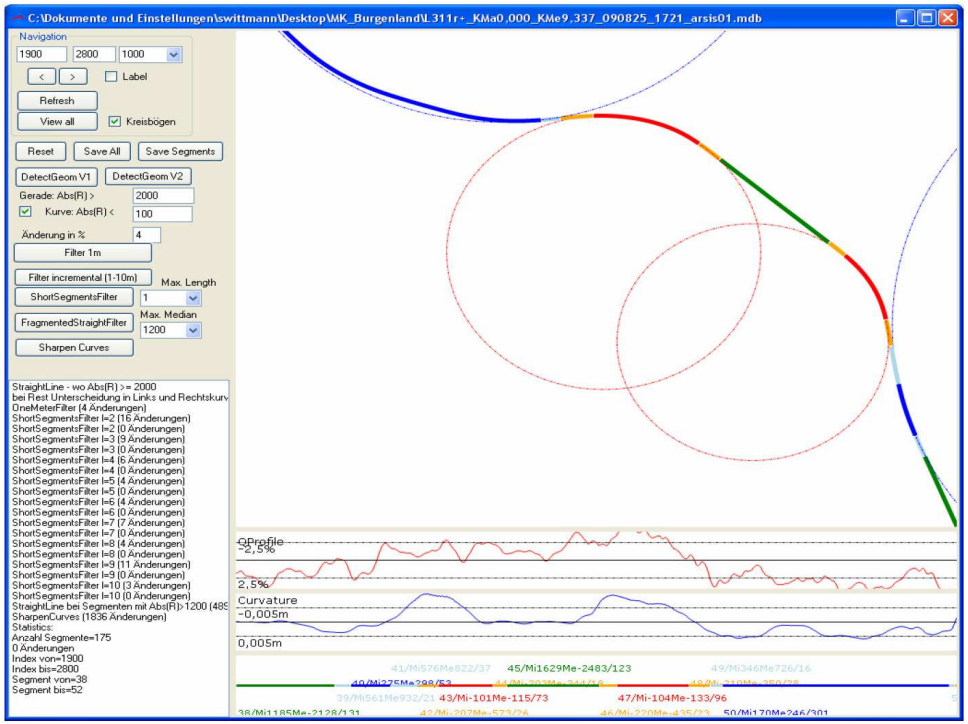
- Black spot in Austria – L311 (km 1,9 bis km 2,6)
- Accident type, road condition, road users involved in crashes – show correlation to the infrastructure influence (crash causes) – run-off road accidents, 70% on wet roads
- 20 accidents in 8 years; 27 users; 20 slightly, 6 severe, 1 fatal

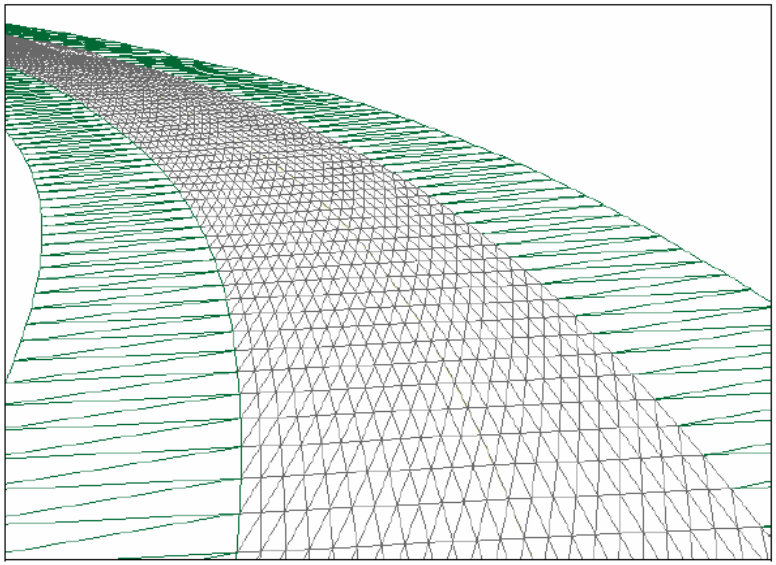




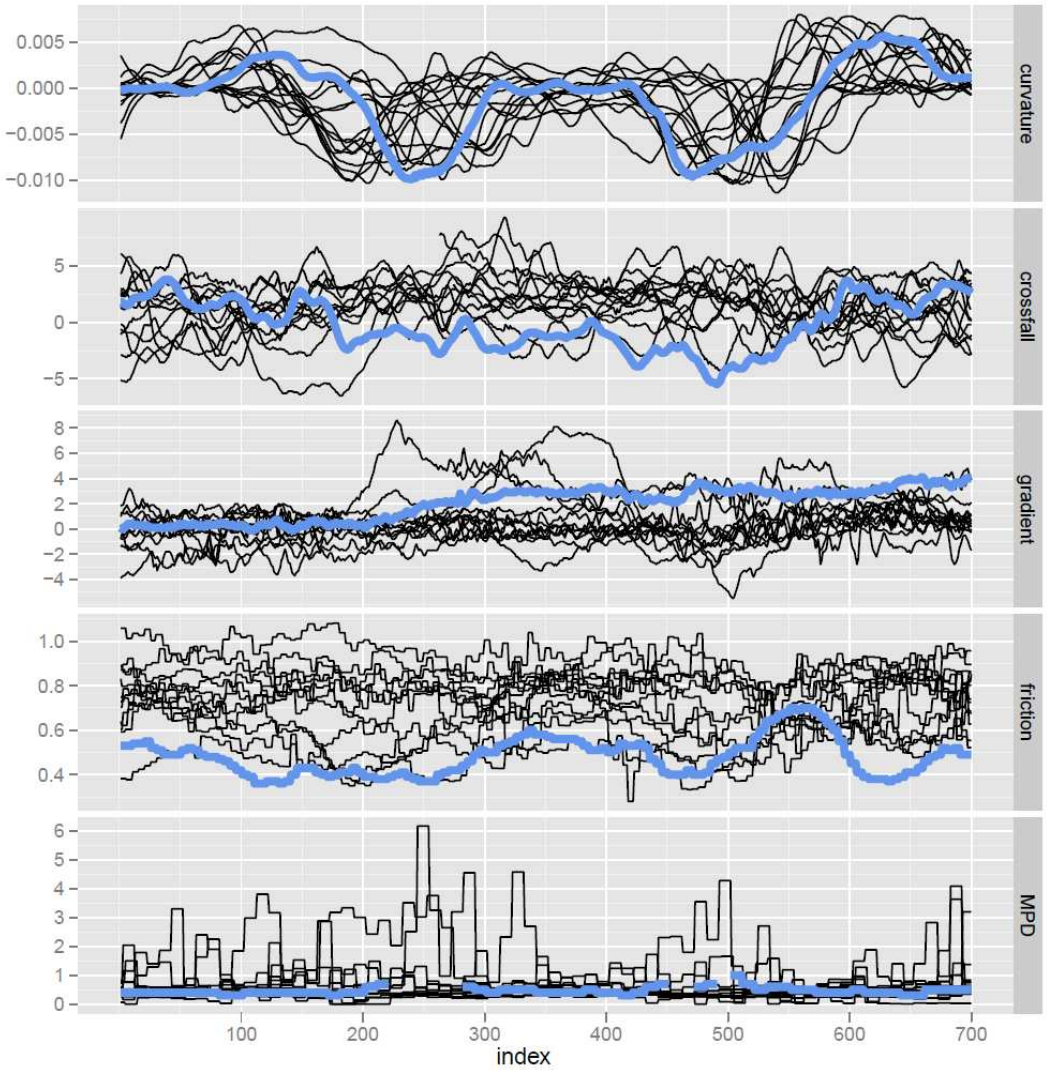
Example (Showcase)

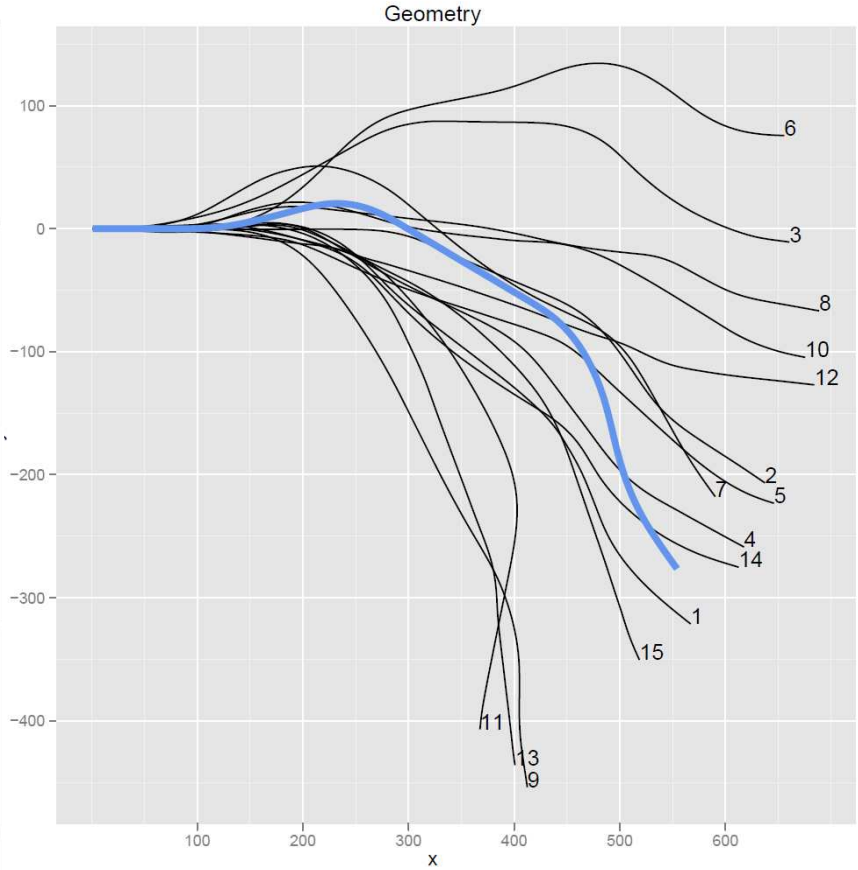
- Template for **Similarity Search** (3D road model)
- RoadSTAR data – to DXF-file in **PC Crash (or Dymola)**
- Sensitivity analyses for L311 und similar roads – critical values of parameters verified with simulation
- Skid resistance partly 0,3; critical radii relations; crossfall o.k.





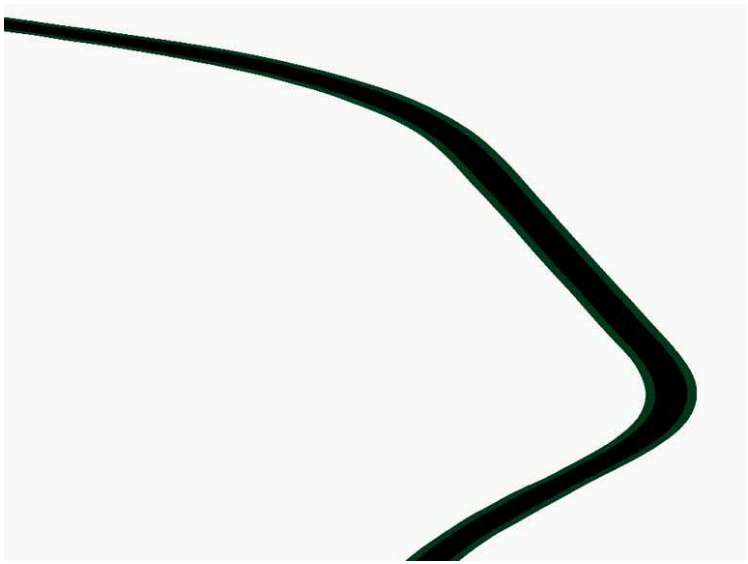
Example (Showcase)

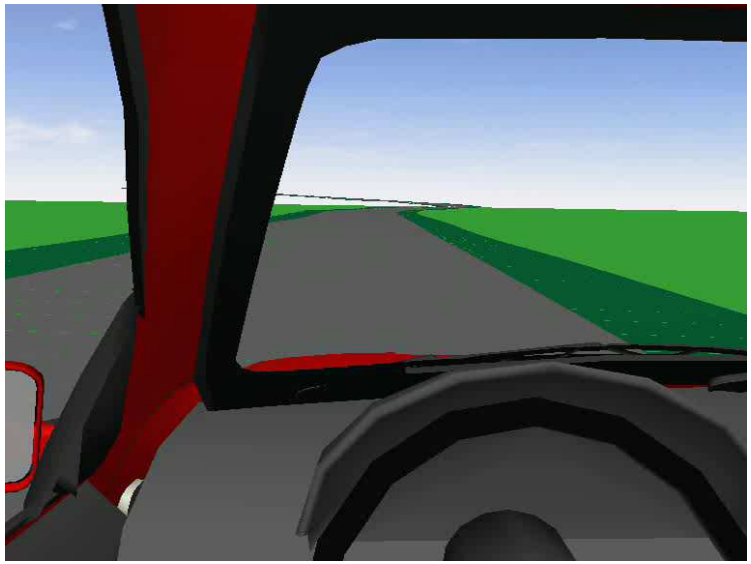




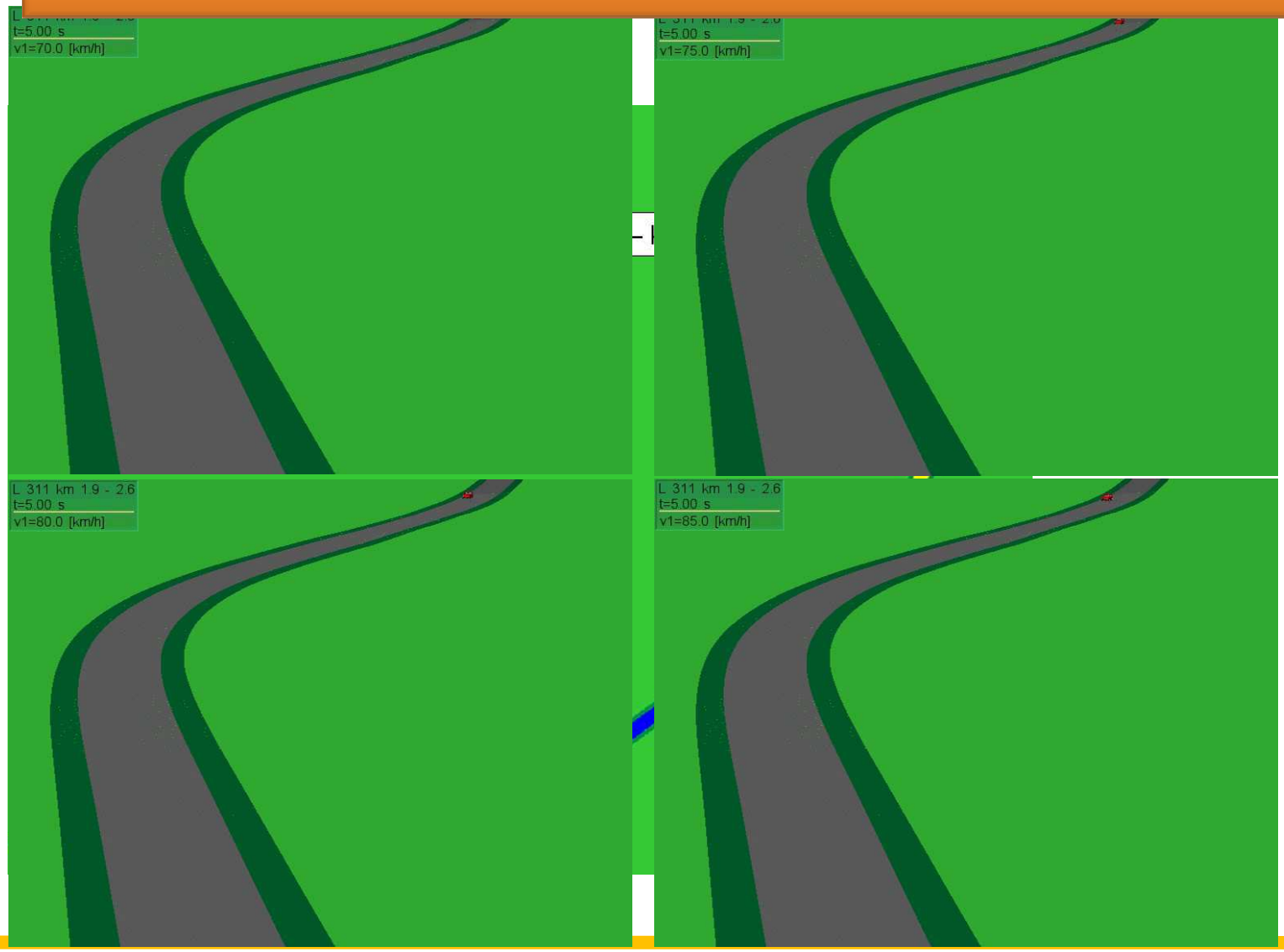
Example (Showcase)

- VIIS simulationen with different parameter combinations
- Max. speed is about 80 km/h
- Increasing of skid resistance shows safe manoeuvre
- Increasing of crossfall in curves decreases risk of skidding
- Forgiving Roadside especially hard shoulders makes the black spot safer

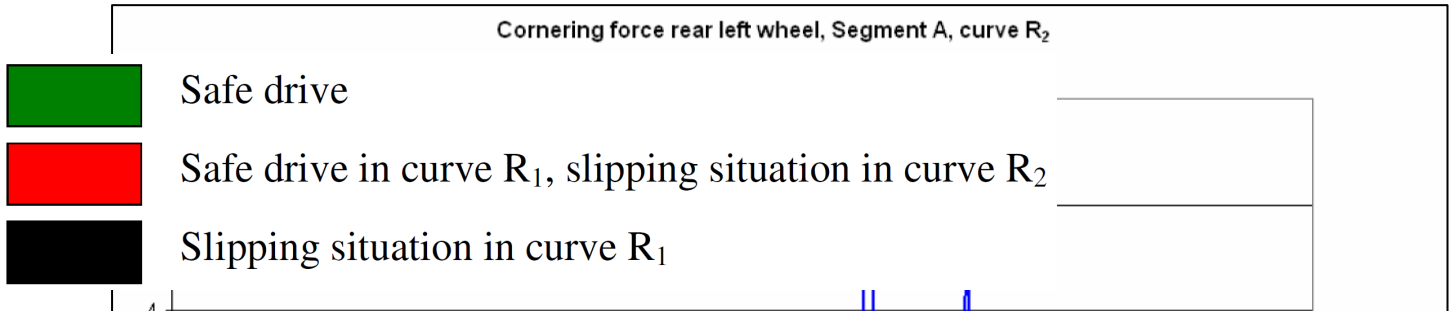




Example (Showcase)

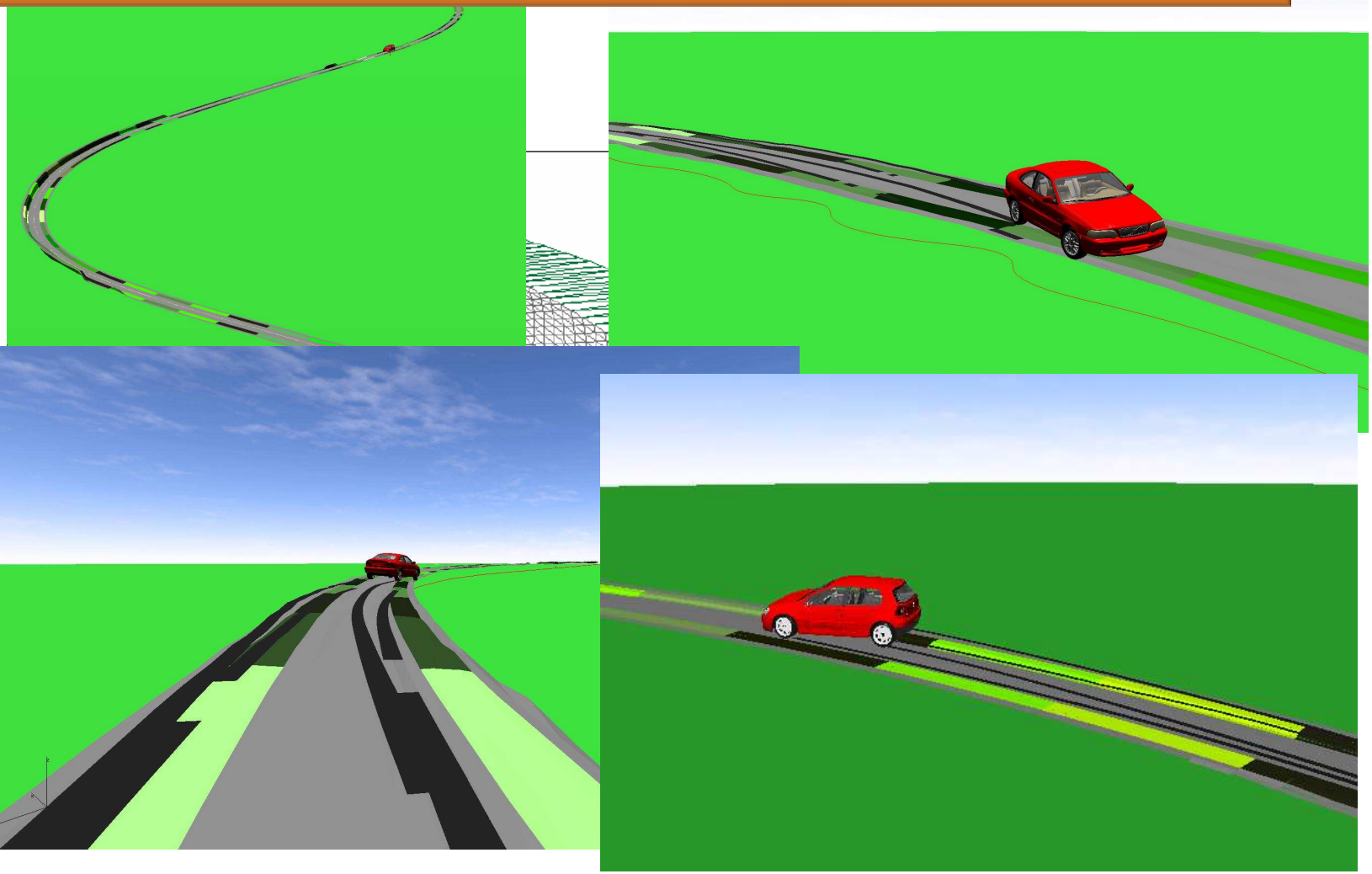


Example (Showcase)

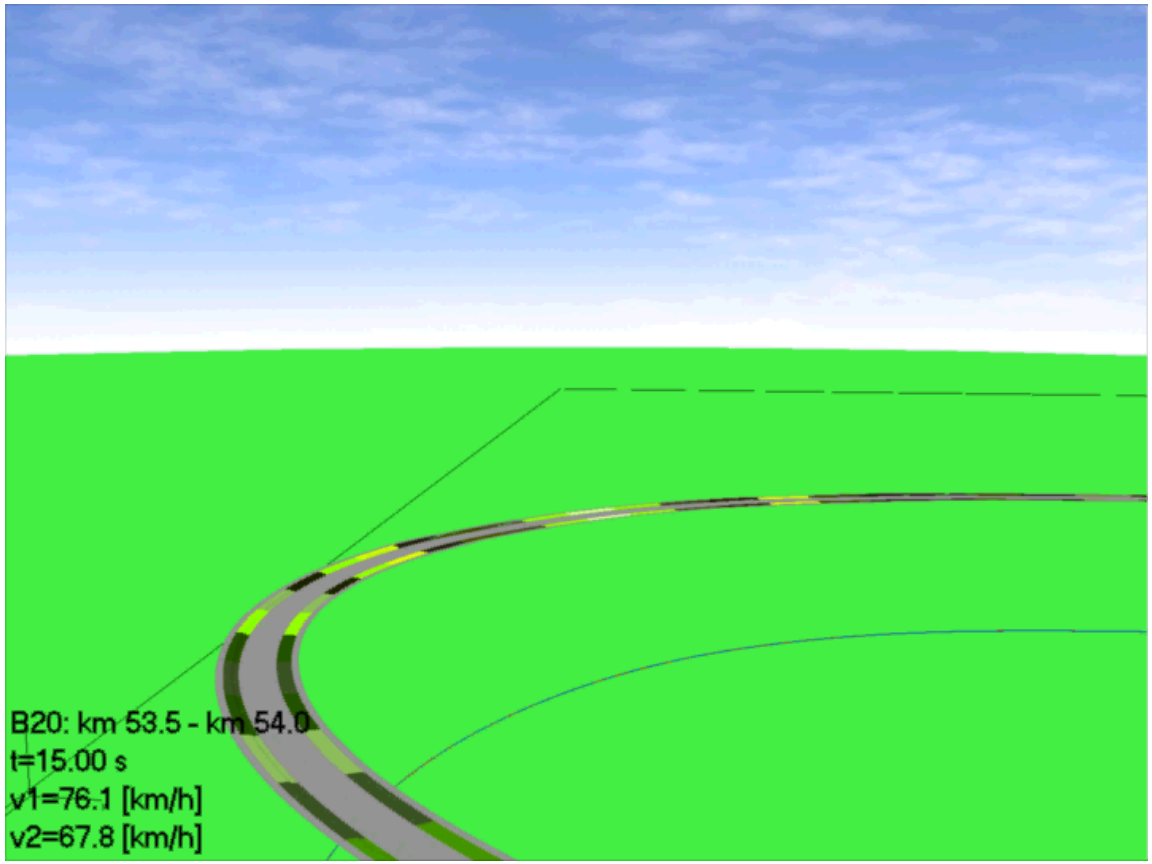


Speed	Skid resistance (μ)							
	0.3	0.4	0.5	0.6	0.7	**0.8**	0.9	1.0
50 km/h								
55 km/h								
60 km/h								
65 km/h								
70 km/h								
75 km/h								
80 km/h								
85 km/h								
90 km/h								
95 km/h								
100 km/h								

Example (Showcase)



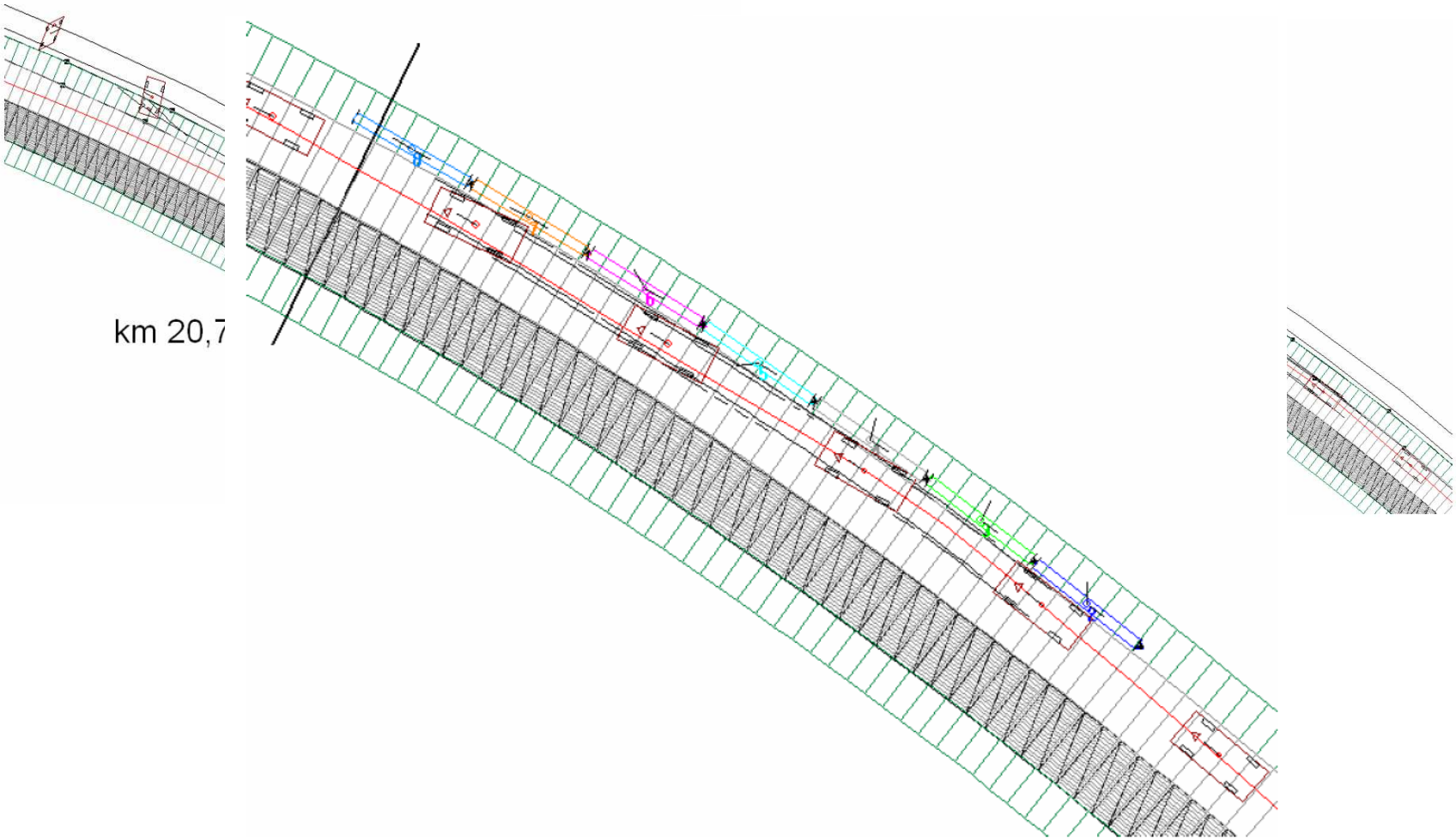
Results



Scenarios in IRDES WP2

- No Forgiving Roadside
- Soft Shoulder
- Hard Shoulder (3 types of friction)
- Tree
- Safety barrier (steel)

Results



Thanks for your attention!

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Safety at the Heart of Road Design

Cross-border funded Joint Research Programme

PRESENTATION N°4

Preliminary results on the effectiveness of grooved rumble strips

(Jan Martinsson, CHALMERS : jan.martinsson@chalmers.se)

Effectiveness of Grooved Rumble Strips

1. What is grooved rumble strips
2. Treated Road vs. Non treated road
3. Accident statistics
4. Preliminary Results

What is grooved rumble strips

Rumble strips are devices designed to generate audible and tactile vibrations as vehicles pass over them. They consist of raised (bumps) or lowered (divots) breaks in the level surface of a roadway and are placed in proximity to the edge of a roadway, to the centerline of a roadway, or in the lane of a roadway.

Milled rumble strips are a type of rumble strip that is ground (cut) into the finished surface of a roadway and constitutes a divot.

Treated VS. Non treated Road

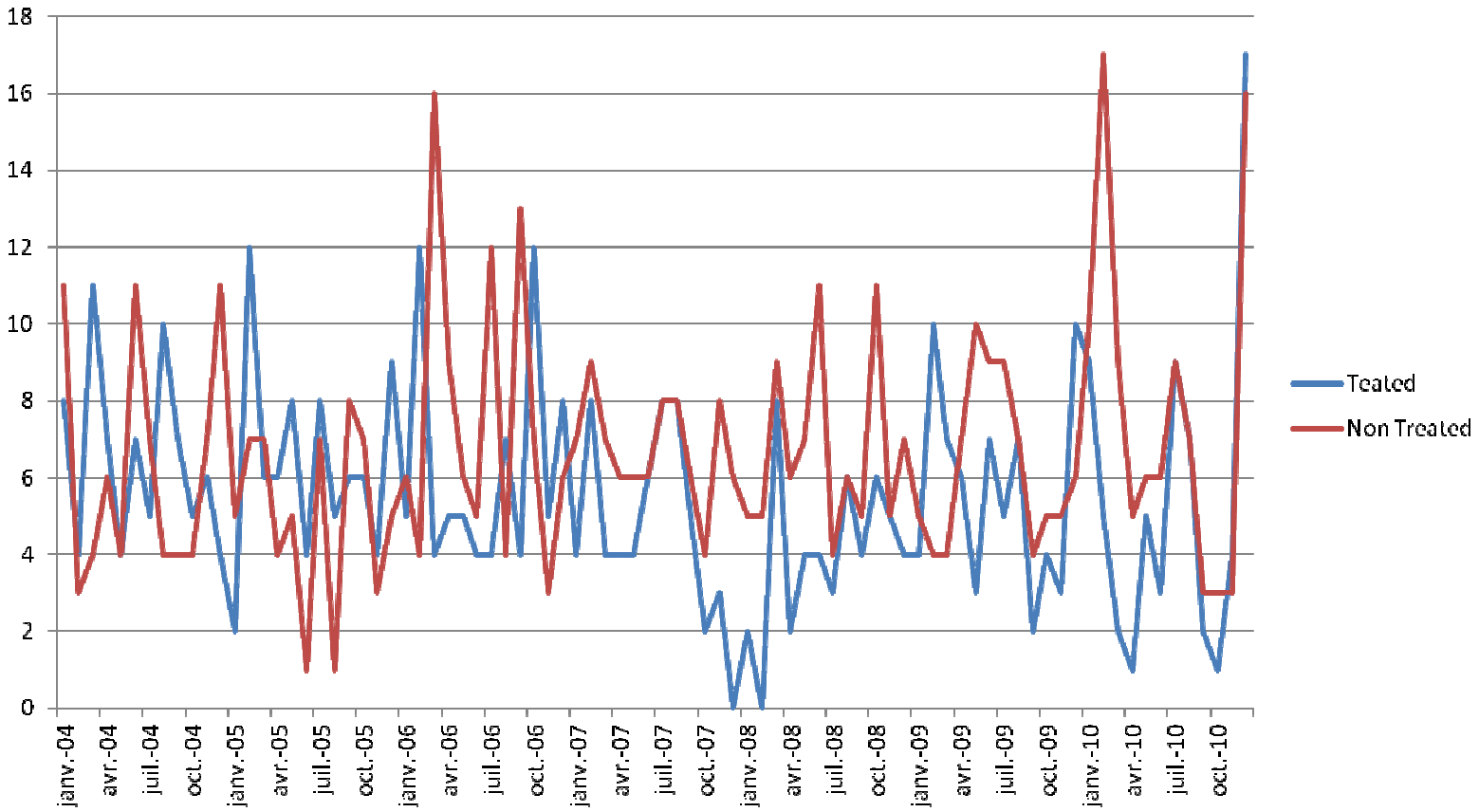
- Treated road (summer 2007)
- 200km
- 1666 million travelled vehicle kilometres per year
- Motorway
- 110-120kmph speedlimit

- Non Treated Road
- 246km
- 1644 million travelled vehicle kilometres per year
- Motorway
- 110-120kmph speedlimit

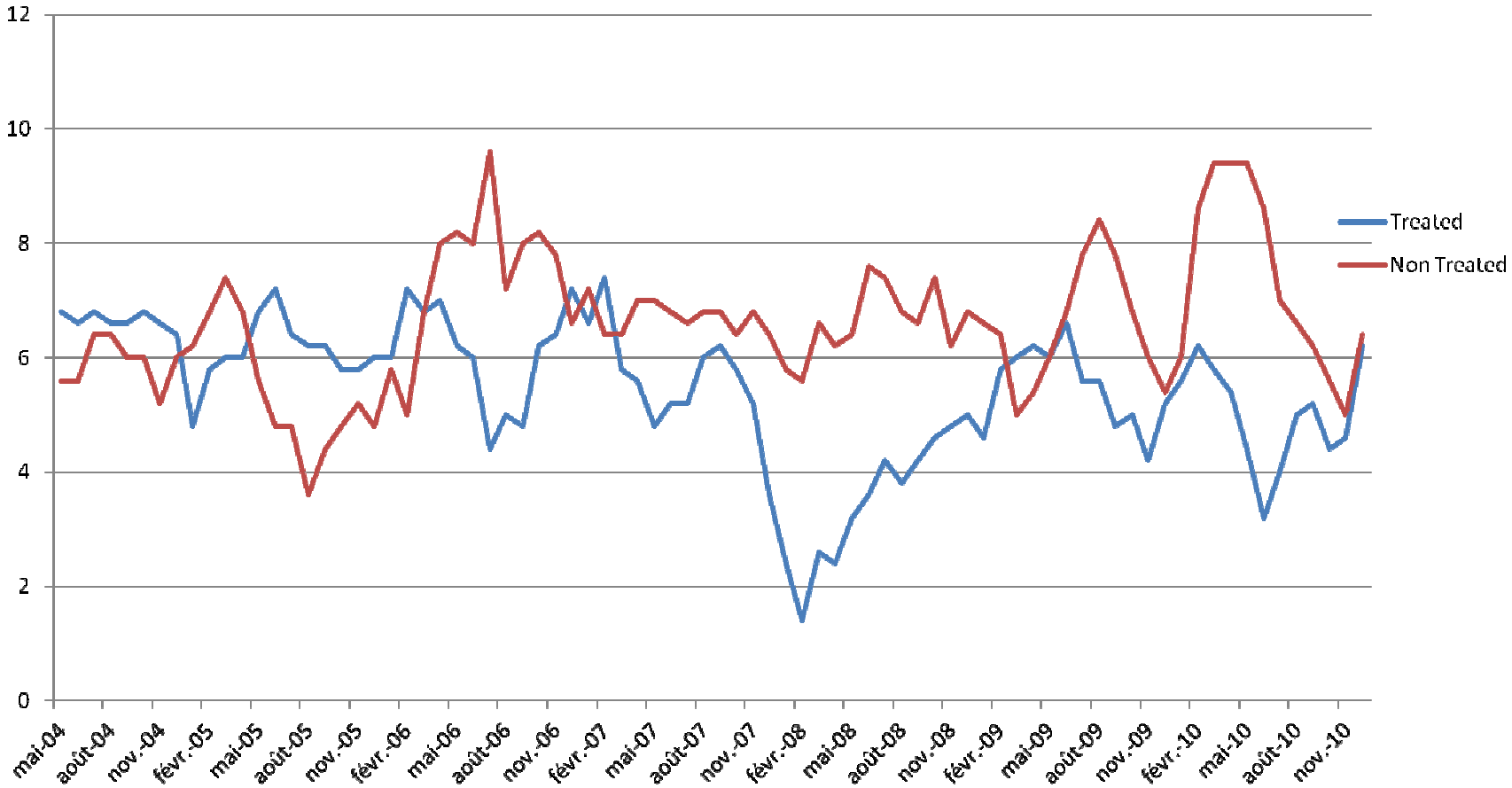
Accident statistics

- Single vehicle accidents between 2004-01-01 and 2010-12-31
- A total of 1024 accidents with at least one injured occupant
- Additional information on light conditions, weather, vehicle type, road surface condition etc.

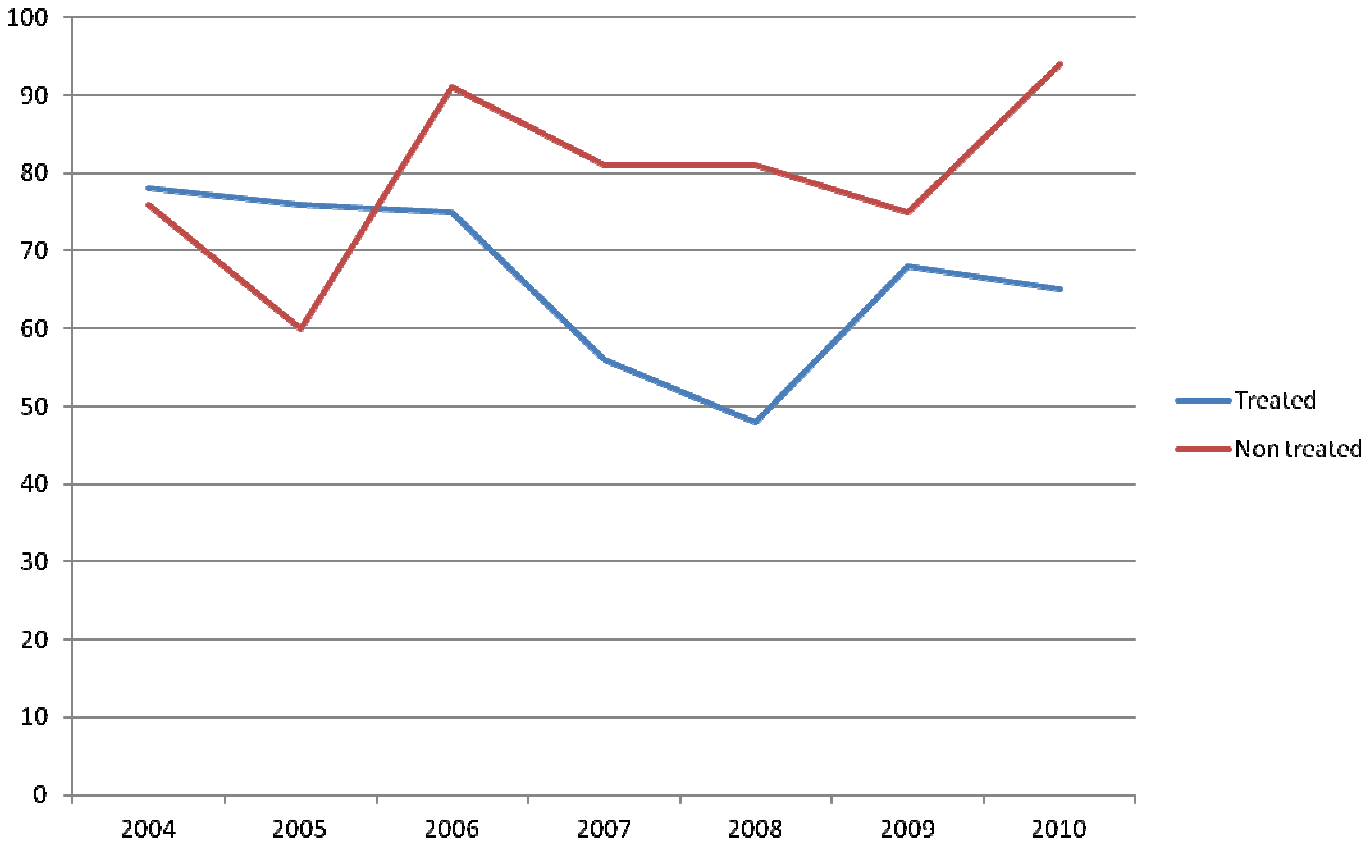
Preliminary results



Preliminary results



Preliminary results



Safety at the Heart of Road Design

Cross-border funded Joint Research Programme

PRESENTATION N°5

Methodology description of a “before and after treatment” study

(Yann Goyat, IFSTTAR : yann.goyat@ifsttar.fr)

Methodology description of a “before and after treatment” study

Goal:

Evaluation of a roadside equipment according to the « behaviors » of the drivers

Methodology – Measurement system

1. Installation of the system named Observatory of Trajectories (OT) on the roadside.

2. Vehicles samples recording

3. Post-processing

4. Validation testing site

Methodology – Measurement system

1. Installation of the system named Observatory of Trajectories (OT) on the roadside :

On two lanes road, we need only rangefinder OT

Methodology – Measurement system

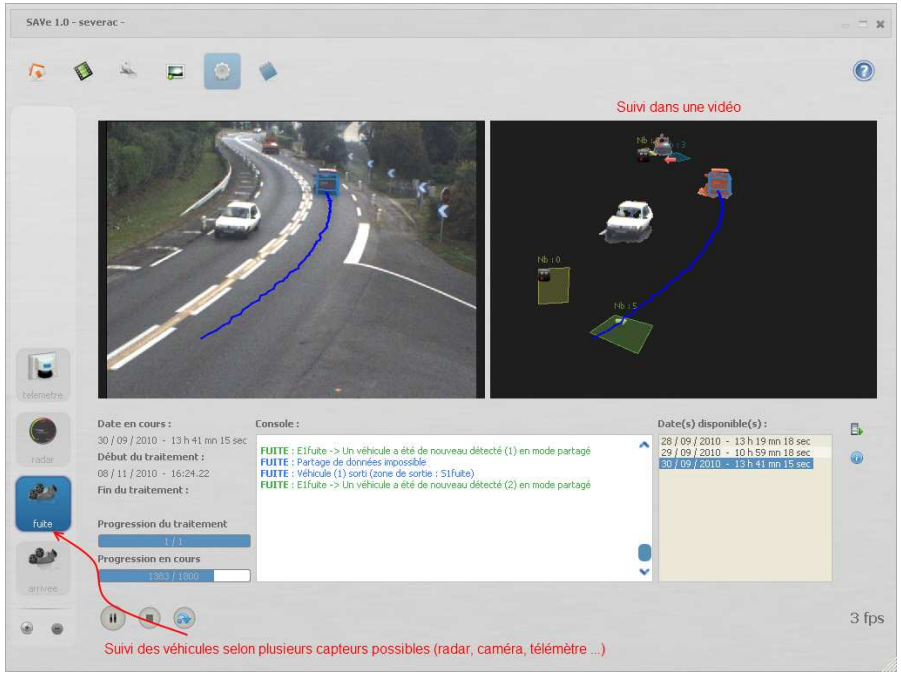
2. Vehicles samples recording :

- **Rangefinder information during 2 minutes each 2 minutes,**
- **« Free » vehicles only (5s) : avoid constraint behavior**
- **One full week : trafic variability during a journey and each day.**

Methodology – Measurement system

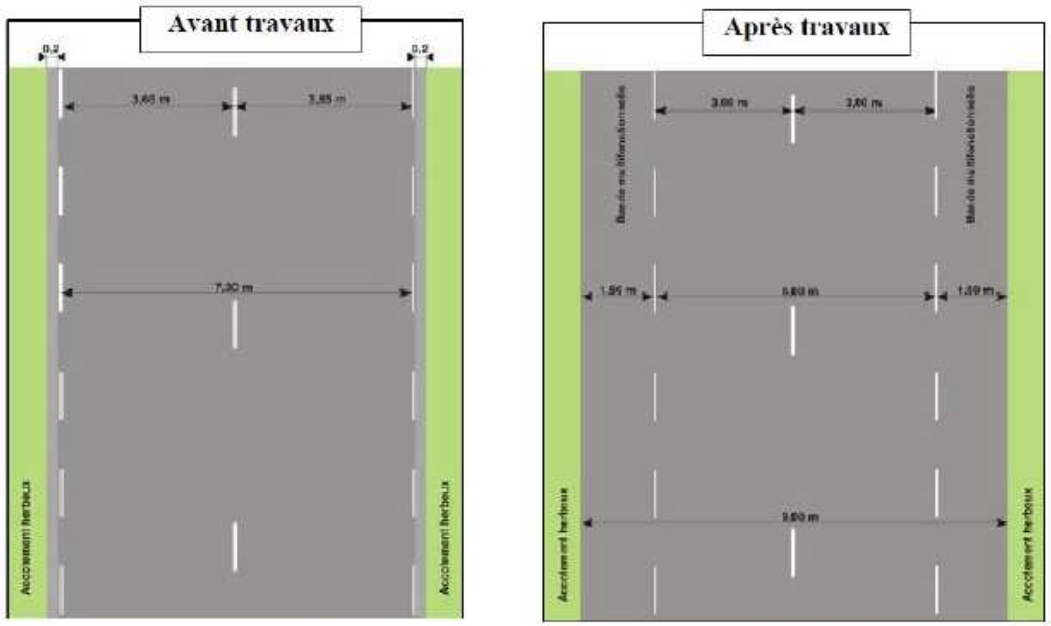
3. Post-processing :

- **SAVe : Software to track vehicles,**



Methodology – Measurement system

4. Testing site : « before » results



Before situation

- 7,30m-wide carriageway
- 0,20m-wide hard strip

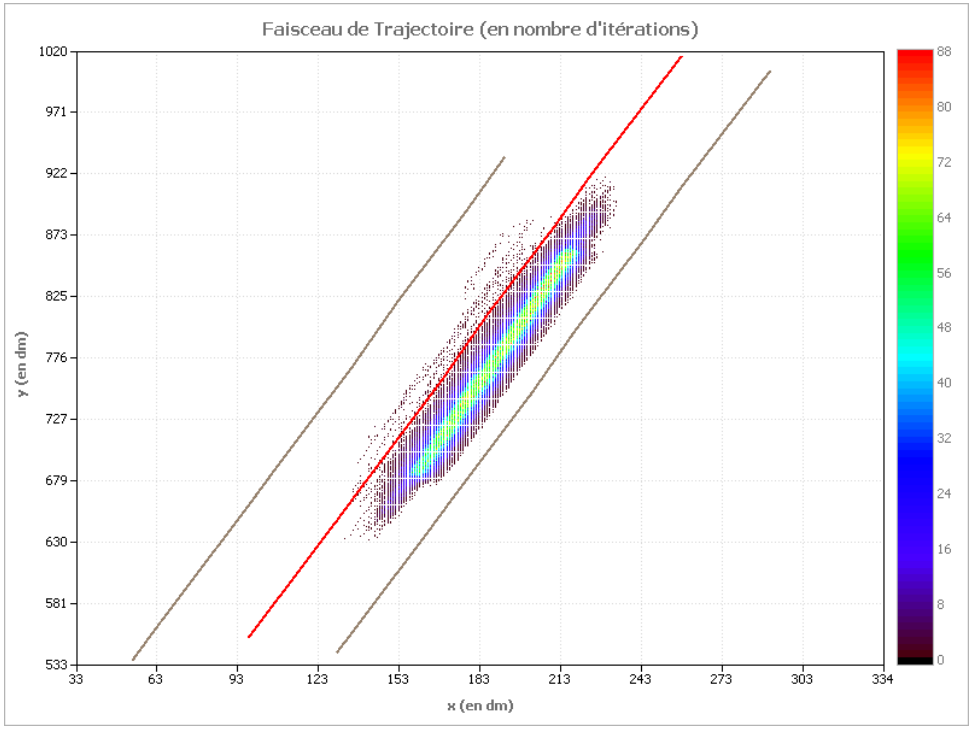
After situation

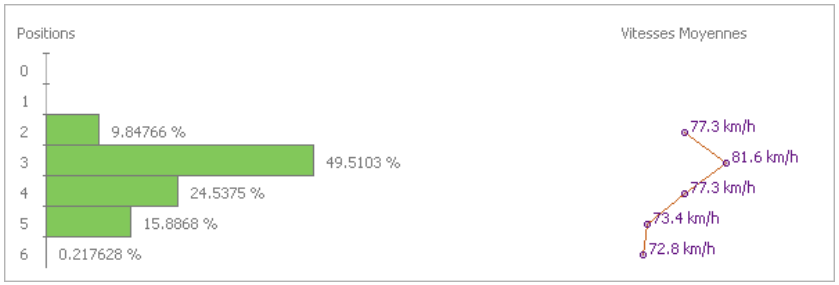
- Lane width is reduced from 3,60 to 3m
- Usable roadway enlarged on both sides
- Provision of 1,50m-wide paved shoulders

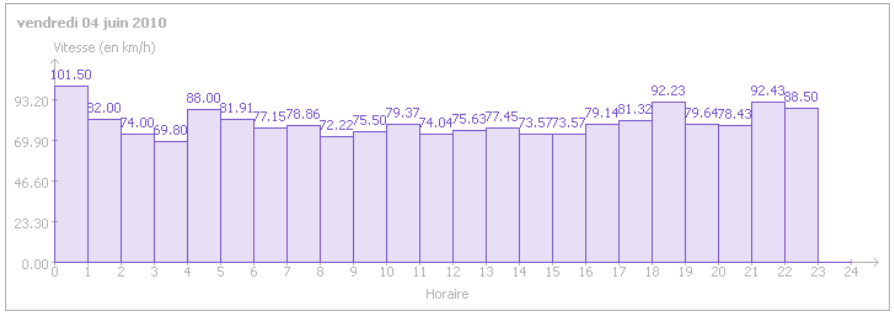
The design consists in managing the road space by both reducing the lane width and providing wider paved shoulders, as shown below.

Methodology – Measurement system

4. Testing site : « before » results







Final steps

1. « After » instrumentation in May

2. Comparison before and after works in June

Safety at the Heart of Road Design

Cross-border funded Joint Research Programme

PRESENTATION N°6

European survey - Questionnaire on Forgiving Roadsides

(Eleonora Cesolini, ANAS : e.cesolini@stradeanas.it)

Outline of the activities

WP0 – Coordination and Management [WP Leader UNIFI]

WP1 – Collection and harmonization of studies and standards on roadside design [WP Leader ARSENAL] ***Duration 12 Months – Start month 1***

WP2 – Assessment of Roadside Intervention Effectiveness [WP Leader CHALMERS] ***Duration 12 Months – Start month 6***

WP3 – Production of a Roadside Design Guide [UNIFI] ***Duration 12 Months – Start month 12***

WP4 – European Survey [WP Leader ANAS] ***Duration 6 Months – Start month 1***

WP5 – Organization of Workshops and Round Tables [WP Leader LCPC] ***Duration 18 Months – Start month 6***

WP4 – European Survey (WP Leader ANAS)

QUESTIONNAIRE

ROADSIDE SAFETY INTERVENTIONS AND THEIR EFFECTIVENESS

The questionnaire was sent to all National Road Authority of the European Community Country and is so made.

The questionnaire is divided into four parts:

1. **General questions**
2. **Roadside treatments**
3. **Assessment of implemented interventions**
4. **New solutions for roadsides**

WP4 – European Survey (WP Leader ANAS)

1st part: General Questions

• Country

• Length of rural network for which the National Road Authority is responsible: Total network

• Motorways

• Highways (single carriageway)

•Highways (dual carriageway)

•Others

WP4 – European Survey (WP Leader ANAS)

2st part: Roadside trea

➢ What about the slope of t
in terms of safety road and v
standard/procedure for calcu

➢ percent of roadsides prot
type of road

➢ Type of roadsides: choose a value between 1 and 5 to evalua
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	☐	☐	☐	☐	☐

WP4 – European Survey (WP Leader ANAS)

2st part: Roadside treatments

- What about the Horizontal signs (markings) and vertical signs in particular:
  - Do you 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?

Vertical sign

  - Do you use roadside delineation to highlight the road edge and obstacles?

- (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	☐	☐	☐	☐	☐

WP4 – European Survey (WP Leader ANAS)

2st part: Roadside treatments

- what about other types of solution for protecting obstacles or delineating the roadside where there are hazards? If yes, please, specify other system(s)

- 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	☐	☐	☐	☐
Wire rope barriers	☐	☐	☐	☐
Horizontal sign	☐	☐	☐	☐
Delineation	☐	☐	☐	☐
Other (specify)	☐	☐	☐	☐

WP4 – European Survey (WP Leader ANAS)

3nd part: Assessment of implemented interventions

- How do you assess each roadside intervention implemented on your network? Answer about concrete guard rails, steel guard rails, wire rope barriers, horizontal sign, delineation, other
- (1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

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

- How do you assess safety performance? Do you use accident data? Accident rate
- Please explain your evaluation method
- Are results on safety performance available for each type of roadside intervention?

WP4 – European Survey (WP Leader ANAS)

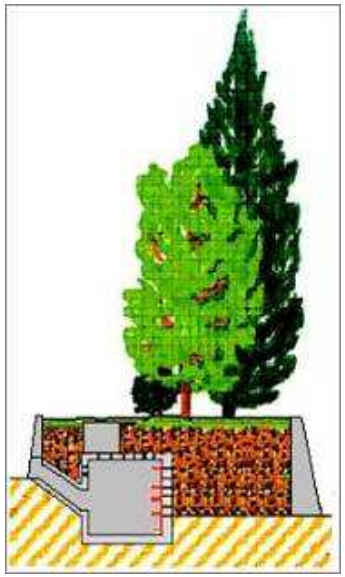
4rd part: New developments and future systems

- Are you satisfied with present treatments for roadside hazards?
- Do you think that adopting new safety principles would improve the situation? 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? 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? Do/Would you use them on your roads?
- Do you know that a change in the shape and slope of embankment slides can improve road safety?

WP4 – European Survey (WP Leader ANAS)

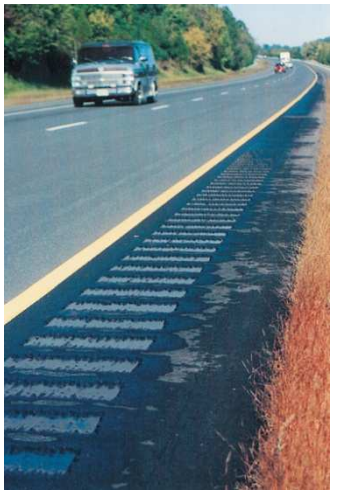
4rd part: New developments and future systems

- Do you use an unpaved shoulder? If no, would you use it?



- Do you use false cutting? If no, would you use it?

- Are you aware of shoulder rumble strips, Do/Would you use this type of intervention? If yes please give me a description



WP4 – European Survey (WP Leader ANAS)

4rd part: New developments and future systems

- **Other**:

- 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?

WP4 – European Survey (WP Leader ANAS)

The results of the questionnaire

WP4 – European Survey (WP Leader ANAS)

Introduction:

The questionnaire was distributed in CEDR environment in order to reach mainly national authorities in charge of national road network. In spite of this objective troubles occurred in getting the answers which resulted not completely homogeneous as expected.

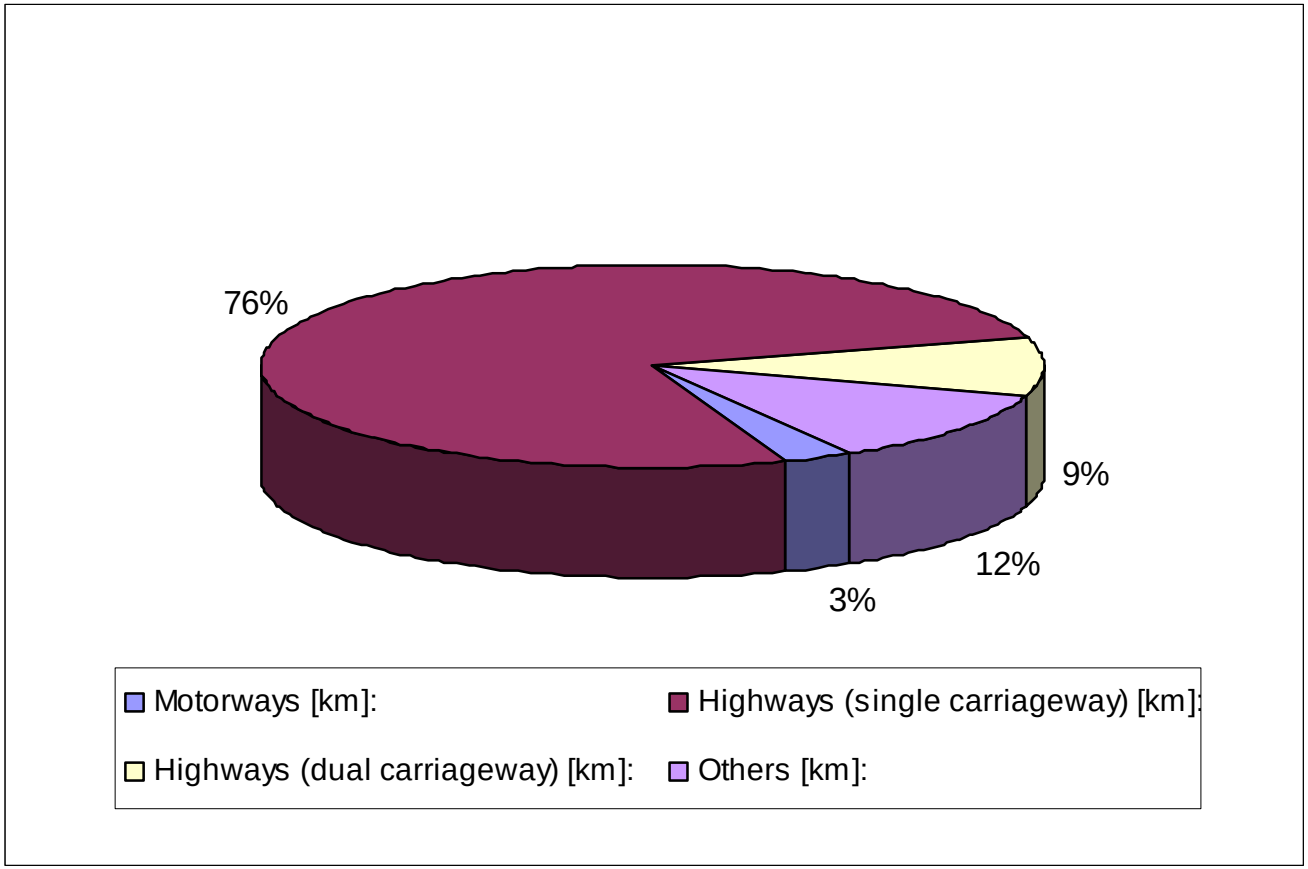
The reason for variable understanding of importance of roadside could come from different legal approach which, in some countries, gives more responsibility to driver behave in comparison with others where driver or passenger must to be protected whatever dangerous is the behave.

WP4 – European Survey (WP Leader ANAS)

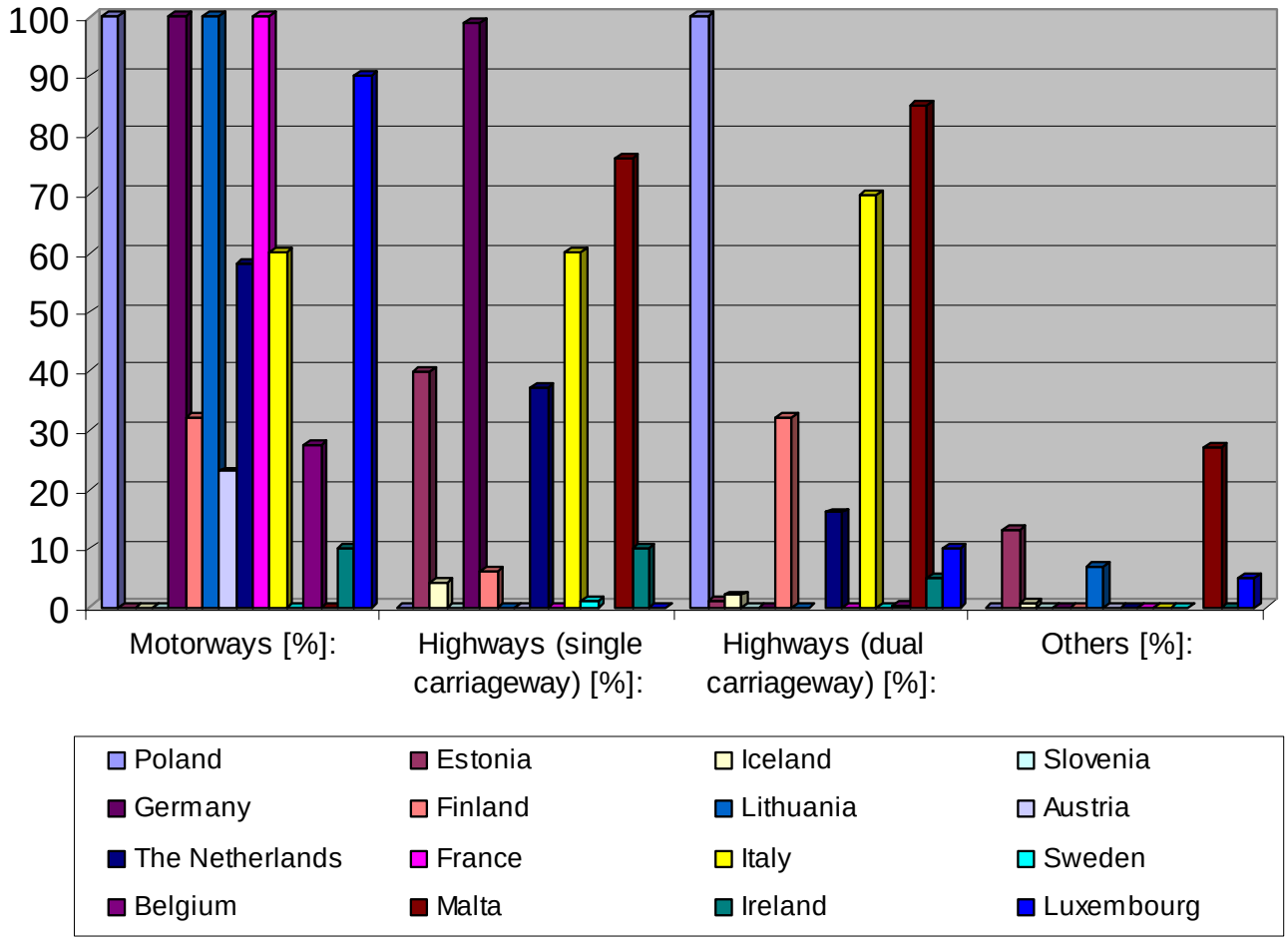
The National Road Authority that answer the questions:

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

LENGTH OF NETWORK BY ROAD FOR ALL COUNTRIES



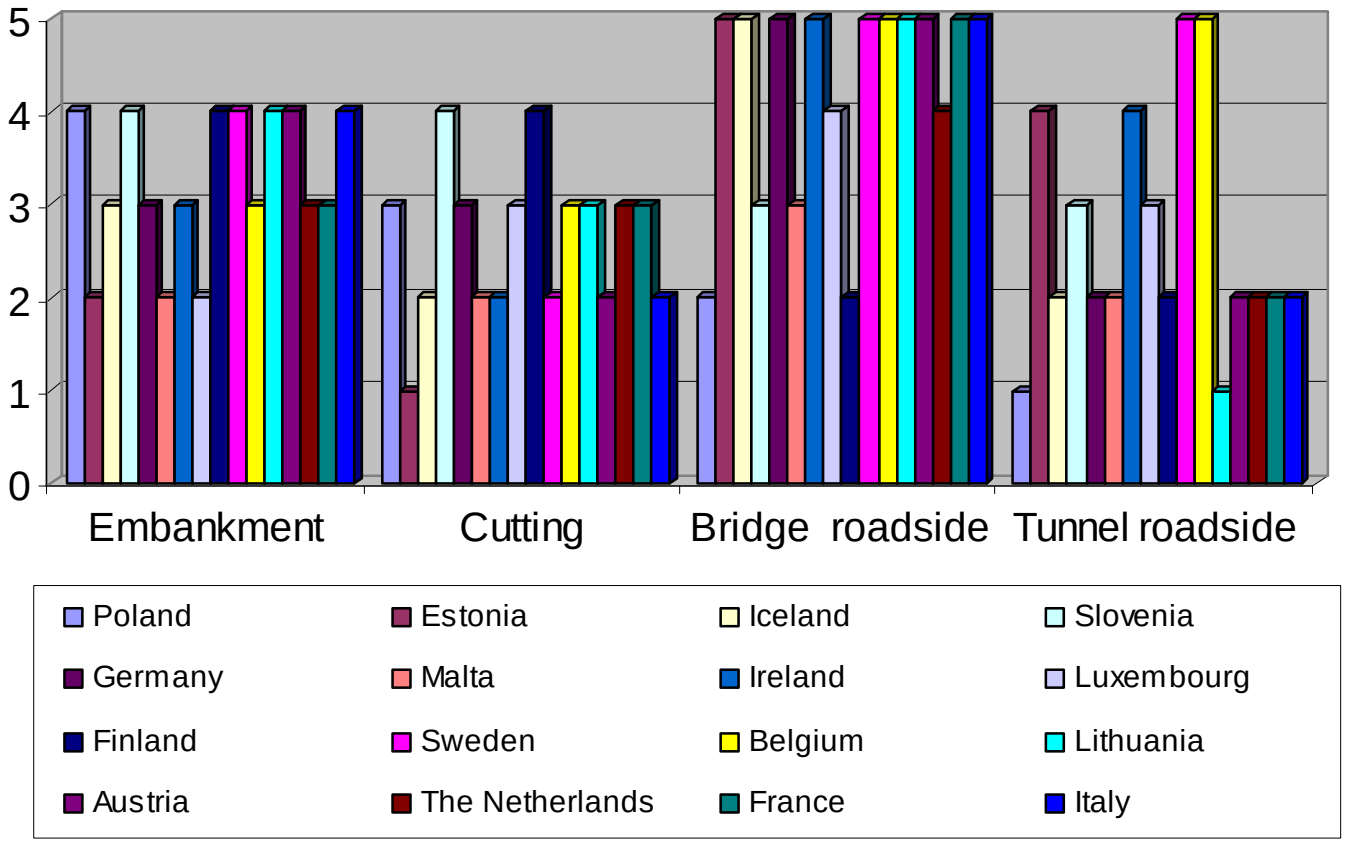
ROADSIDE PROTECTED WITH SAFETY BARRIERS FOR ALL COUNTRIES



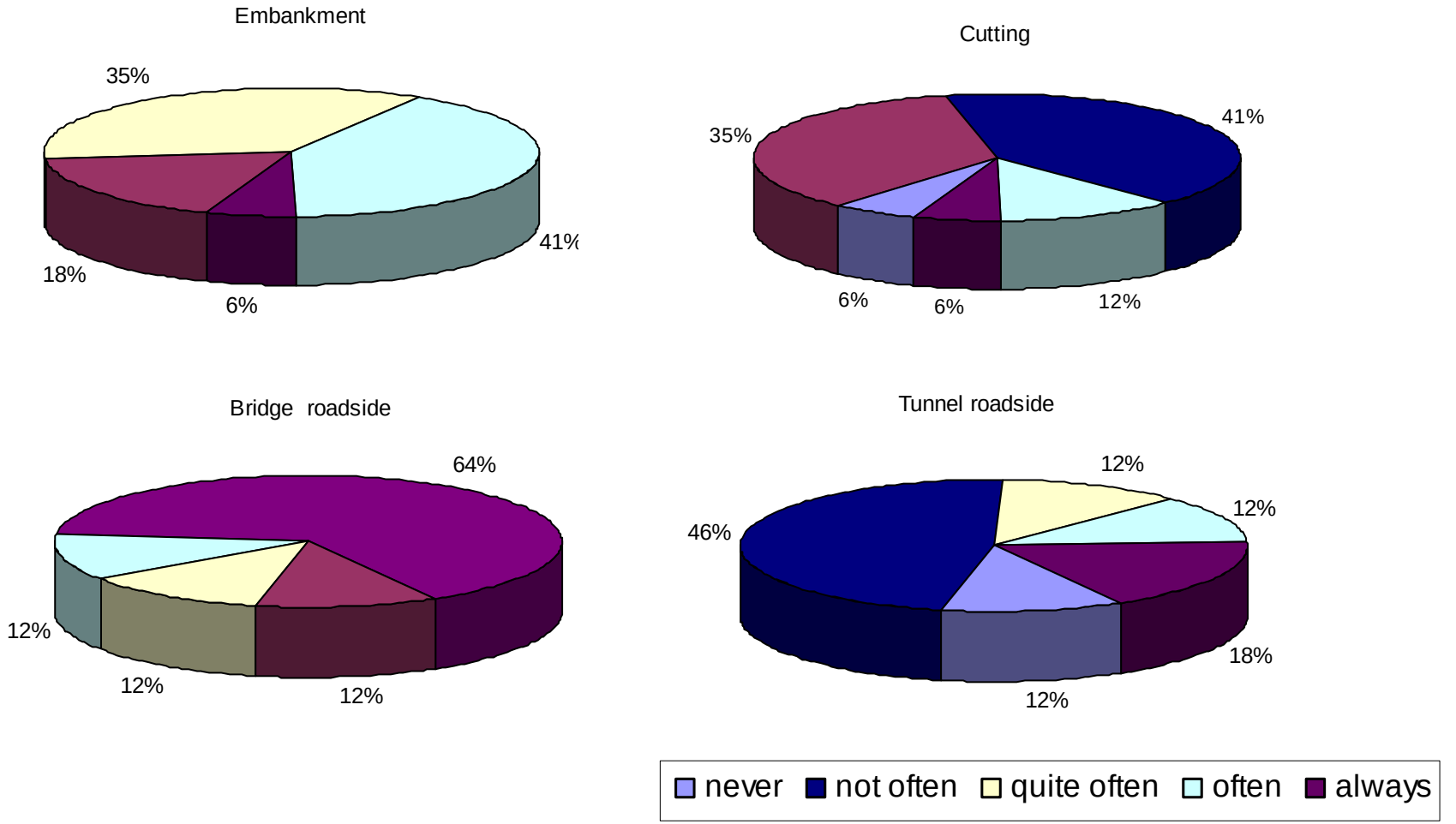
The value "0" as not declare and not as "0 percent"

TYPE OF ROADSIDES: HOW OFTEN THEY ARE PROTECTED WITH SAFETY BARRIERS

(1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always)

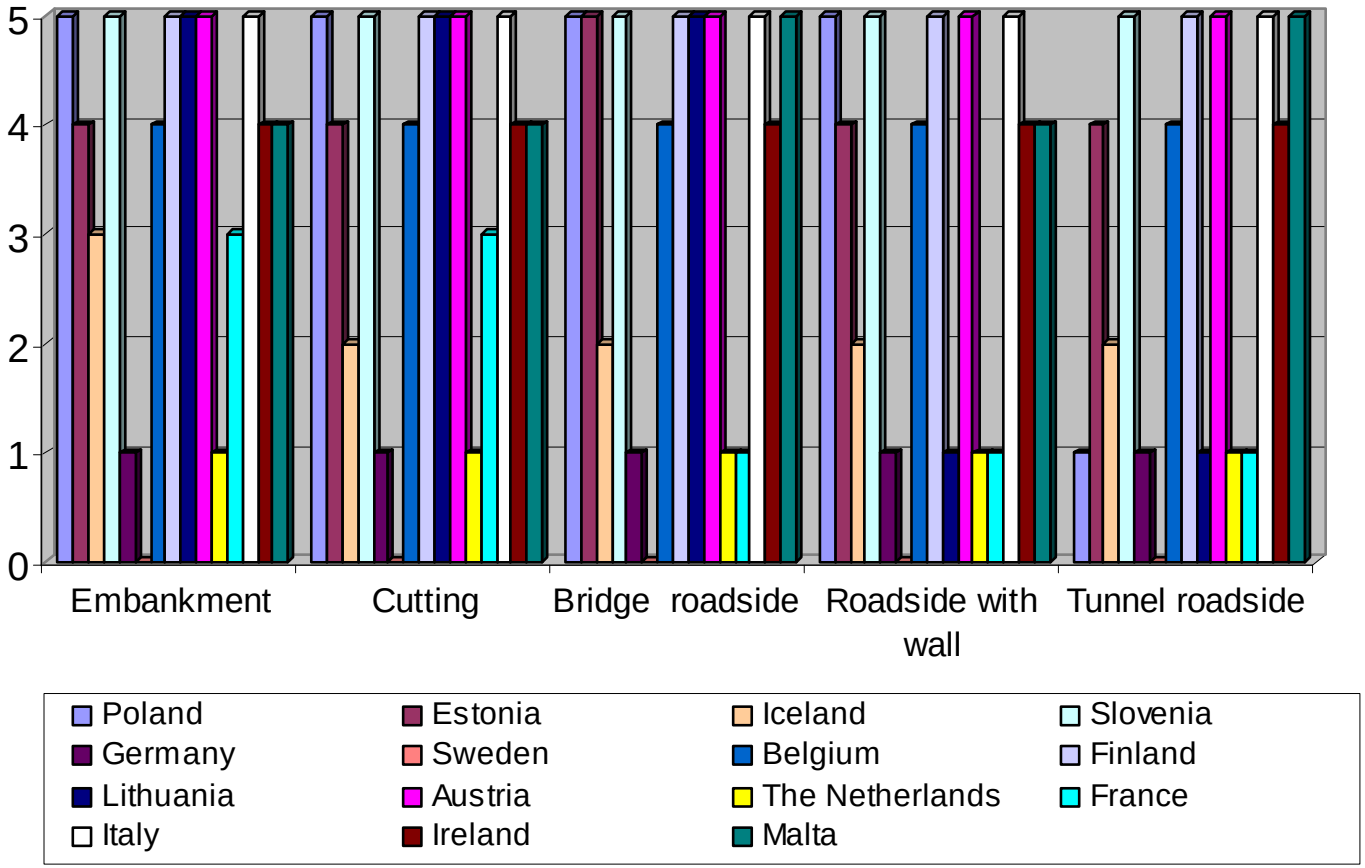


TYPE OF ROADSIDES: HOW OFTEN THEY ARE PROTECTED WITH SAFETY BARRIERS BY ROADSIDES FOR ALL COUNTRIES



Do you 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?

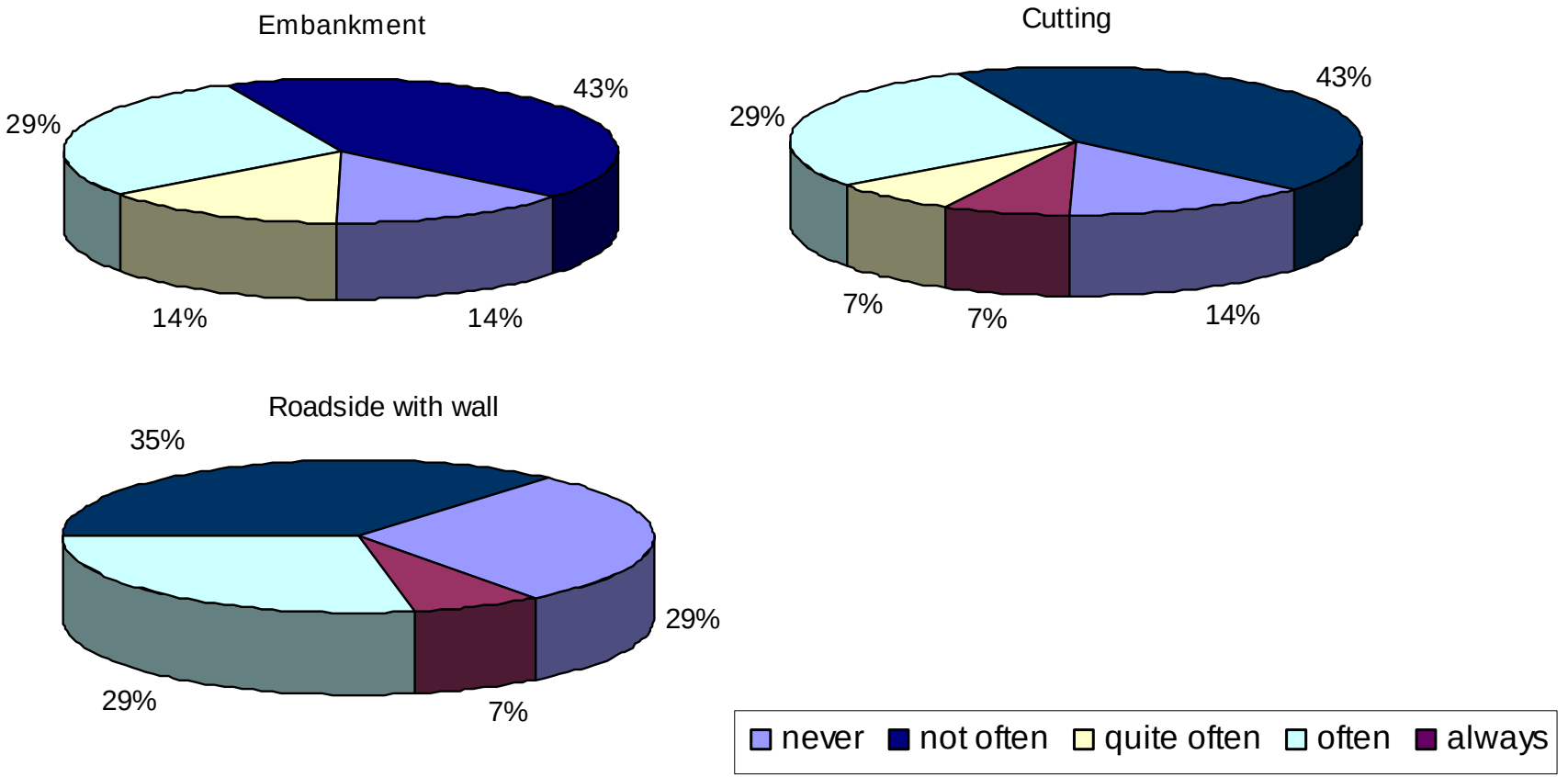
(1:never; 2:not often; 3:quite often; 4:often; 5: always)



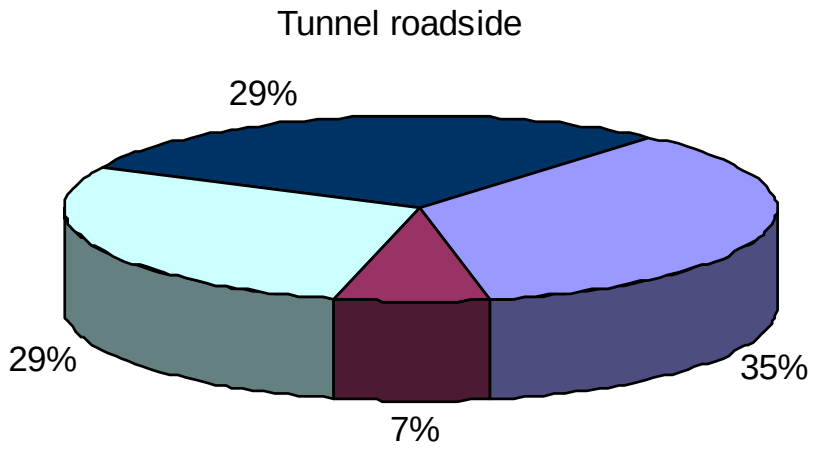
Sweden and Luxembourg not answered

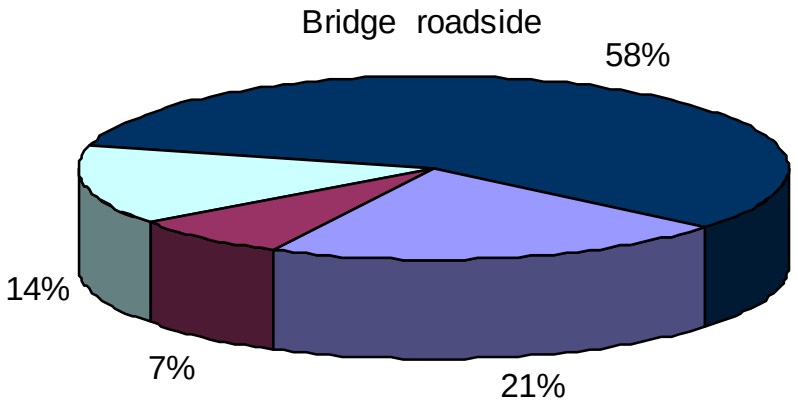
SPECIAL HORIZONTAL MARKINGS:

How often they are used 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 by roadsides for all countries



SPECIAL HORIZONTAL MARKINGS:
How often they are used 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 by roadsides for all countries



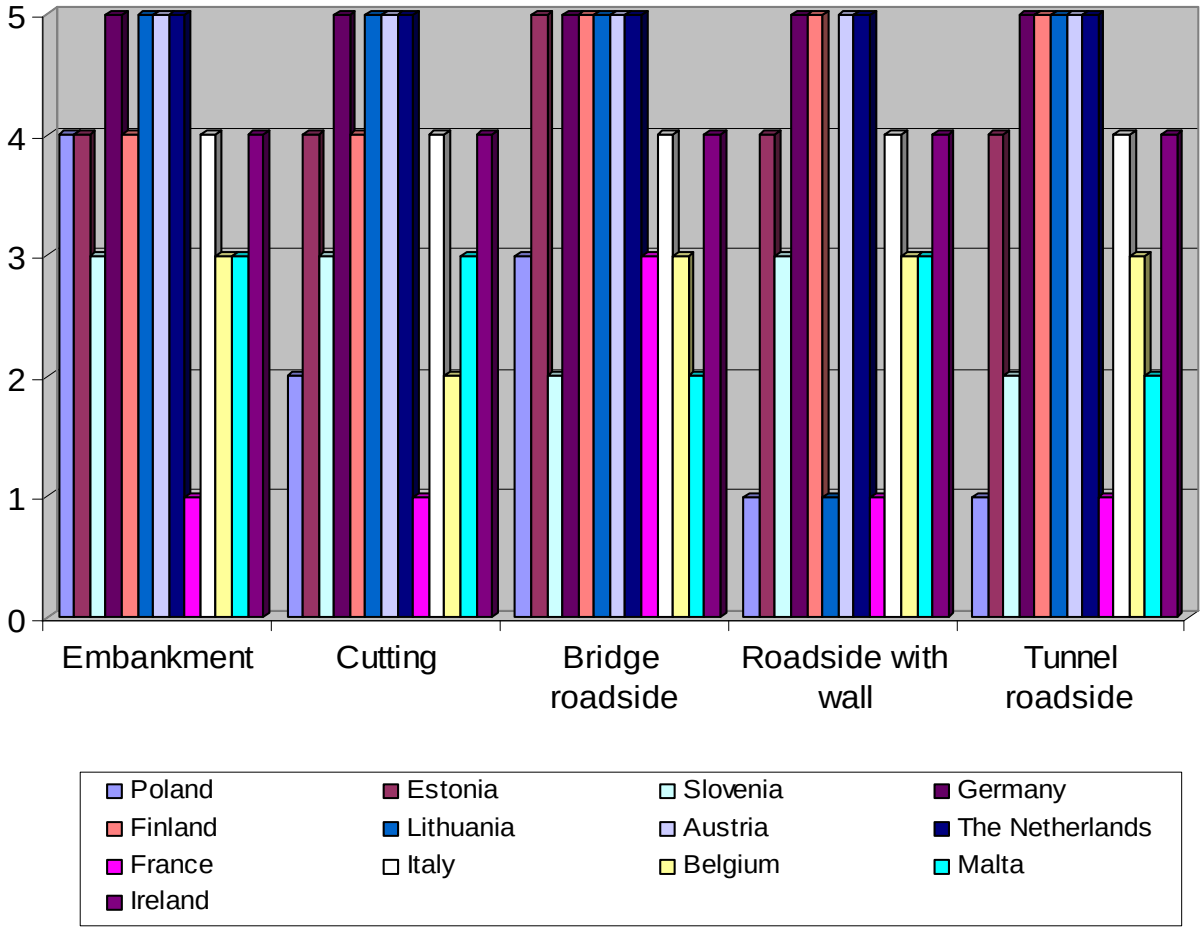


never | not often | quite often | often | always

VERTICAL SIGNS:

Do you use roadside delineation to highlight the road edge and obstacles?

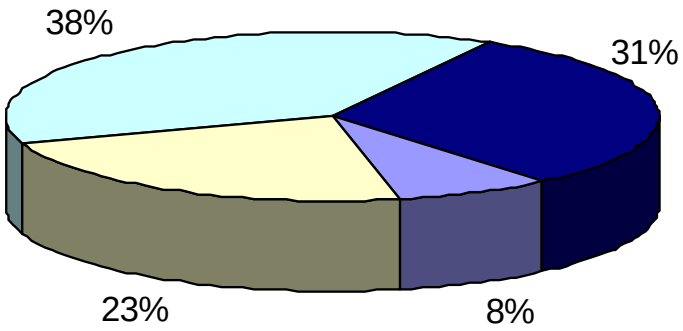
(1 = never; 2 = not often; 3 = quite often; 4 = often; 5 = always)



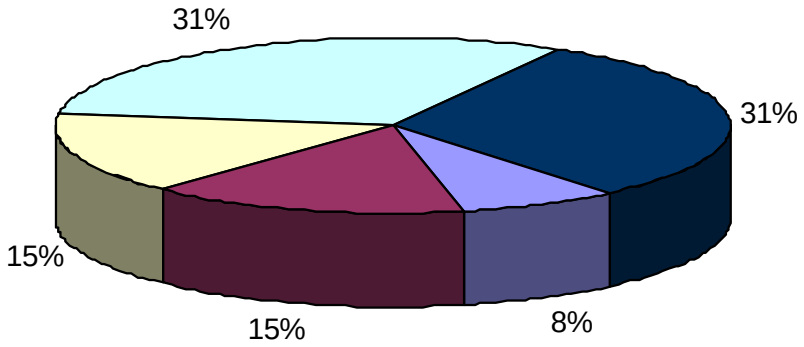
Island, Sweden and Luxembourg not answered

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

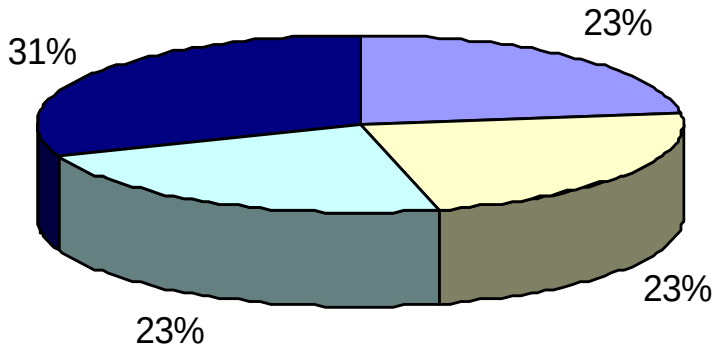
Embankment

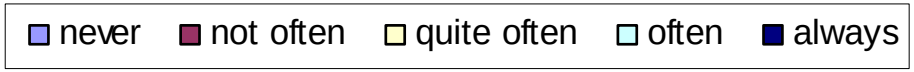


Cutting



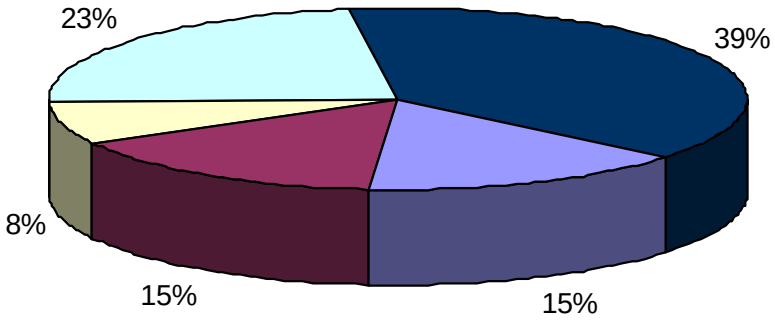
Roadside with wall



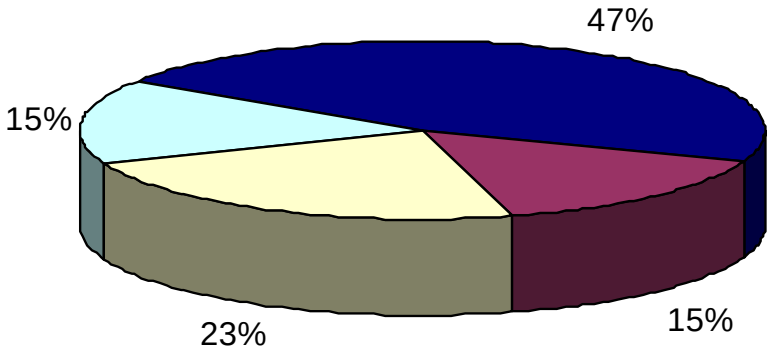


VERTICAL SIGNS:
How often they are used on roadsides delineation to highlight the road edge and obstacles by roadside for all countries

Tunnel roadsides



Bridge roadside

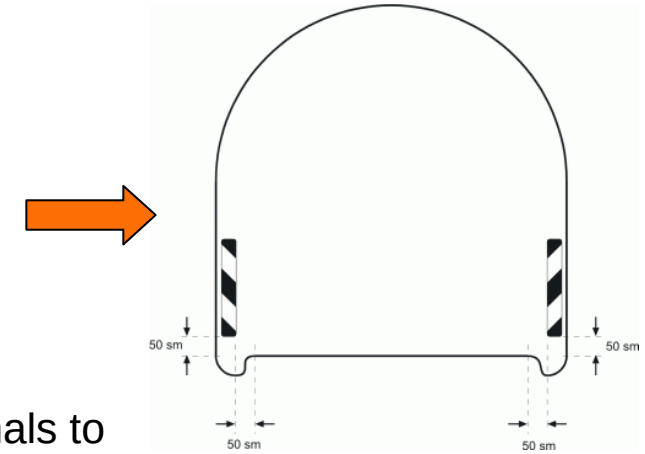


never | not often | quite often | often | always

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.



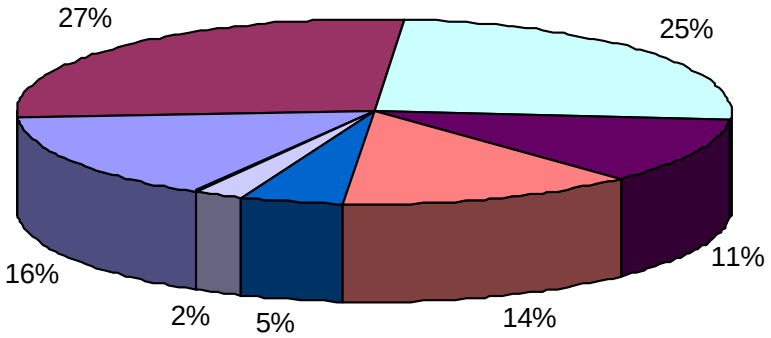
IRELAND: vehicle Activated Signs with associated warning signals to alert drivers to sharp bends ahead or other hazards.

ITALY: emergency lane, parking zones, SOS posts, high-impact sign (i.e. lighting systems, etc.), energy absorption system, rumble strips, in general. Special bridge barriers, wind protections, antiglare devices on bridges.

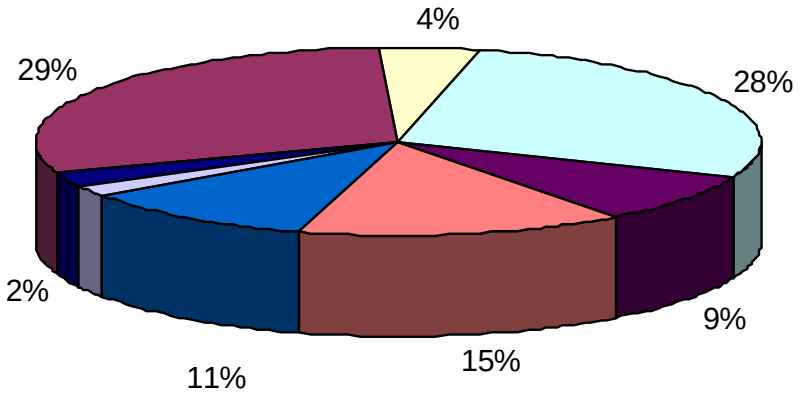
LUXEMBOURG: repetition of signs along the road, automatic detection signs “danger” with flashs.

WHICH TYPE OF INTERVENTIONS ARE USED PREDOMINANTLY ON YOUR ROADS?

MOTORWAY



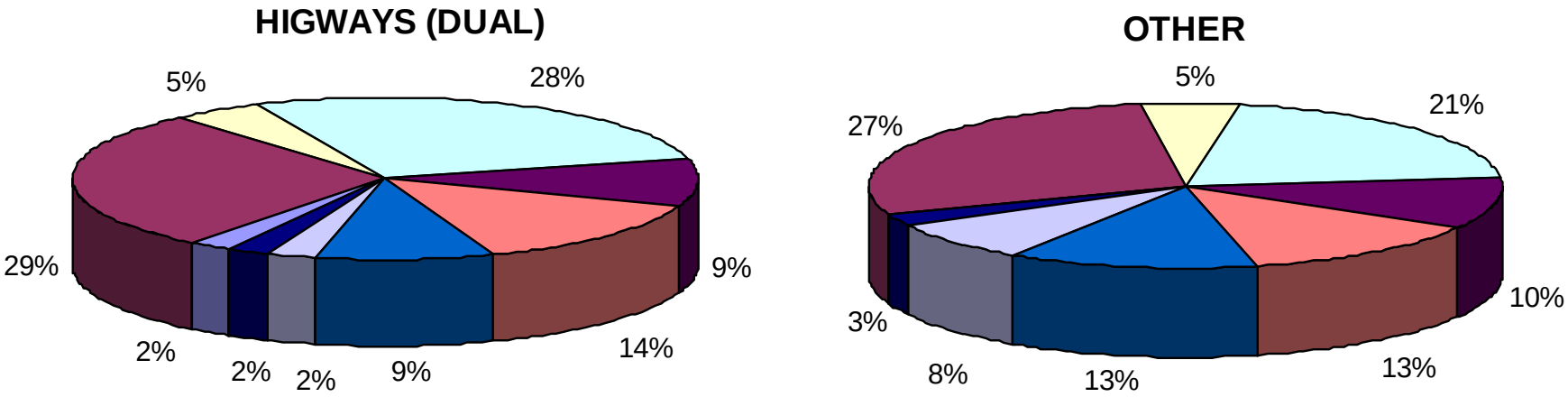
HIGWAYS (SINGLE)



- Concrete guard rails
- Steel guard rails
- Wire rope barriers
- Horizontal sign
- Fences
- Verticla signs
- Delination
- Walls
- Other (specify)

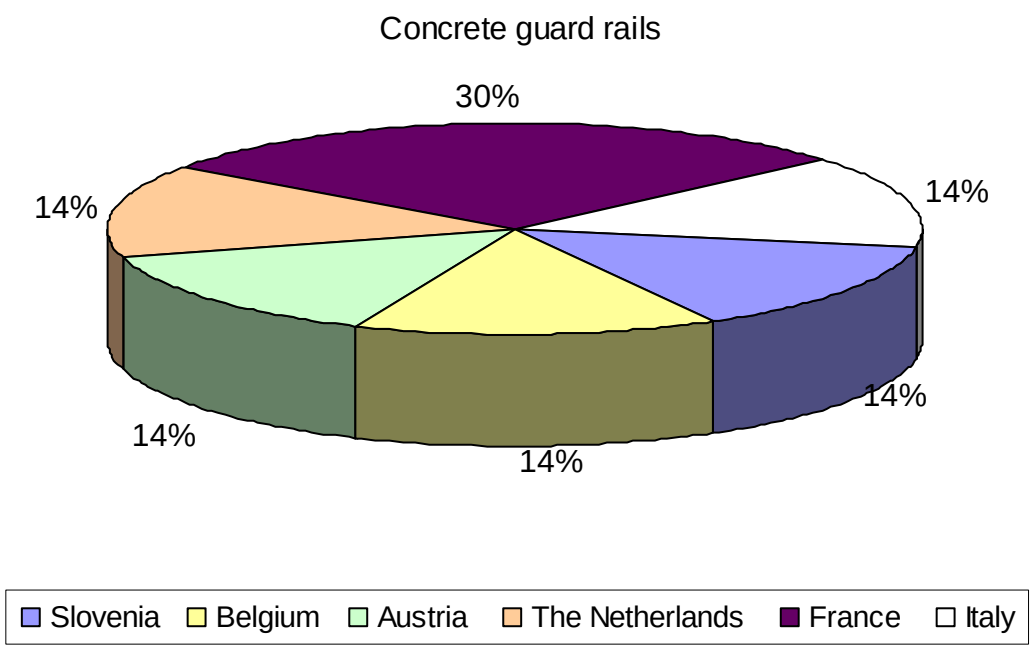
NOTE : Sweden not answered

WHICH TYPE OF INTERVENTIONS ARE USED PREDOMINANTLY ON YOUR ROADS?

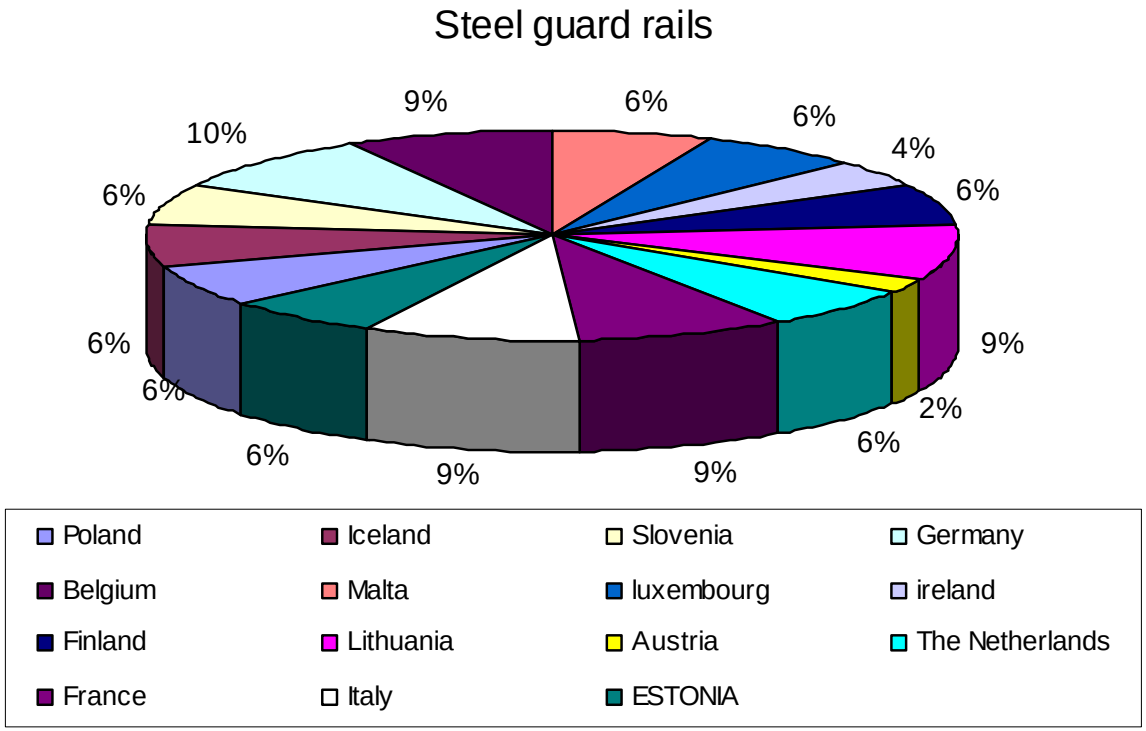


NOTE : Sweden not answered

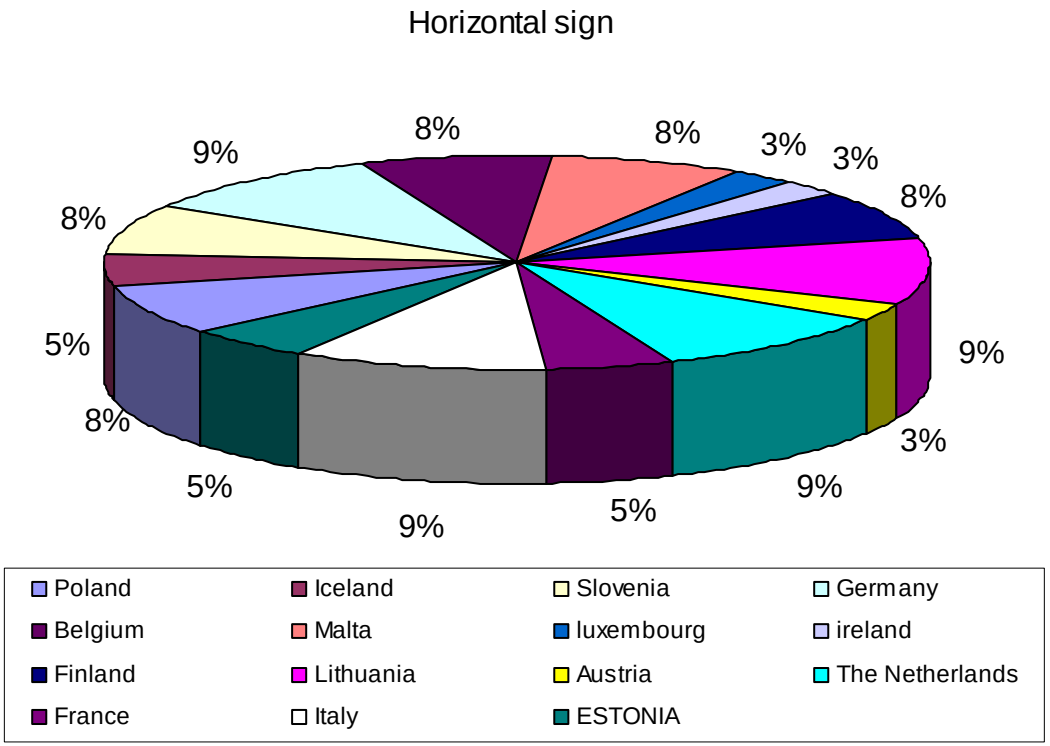
CONTRIBUTE PERCENT OF SINGLE COUNTRY TO TYPE OF INTERVENTIONS FOR ALL TYPE OF ROADS



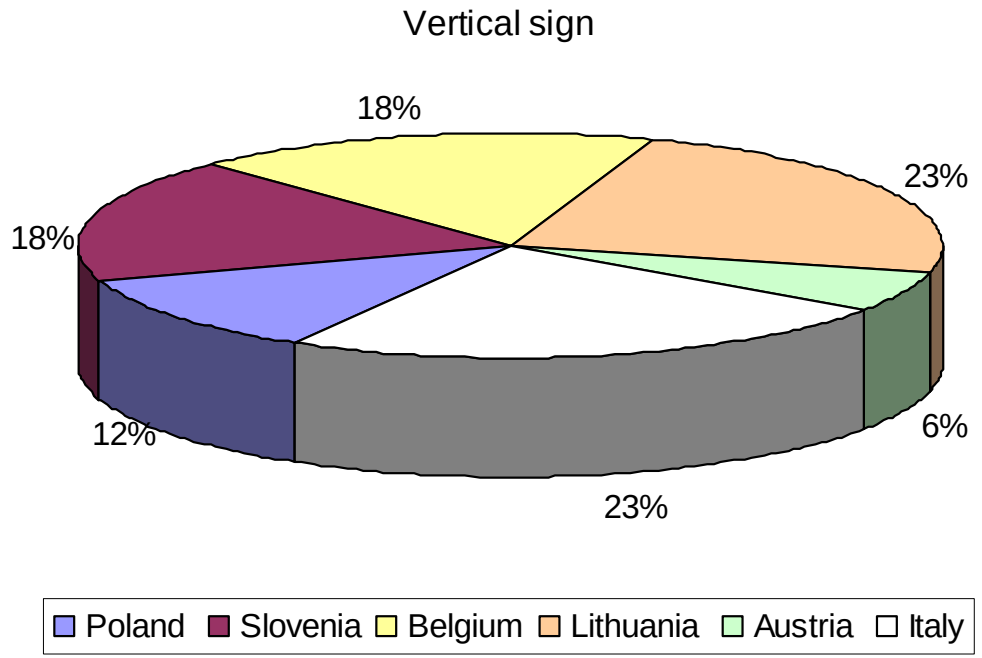
CONTRIBUTE PERCENT OF SINGLE COUNTRY TO TYPE OF INTERVENTIONS FOR ALL TYPE OF ROADS



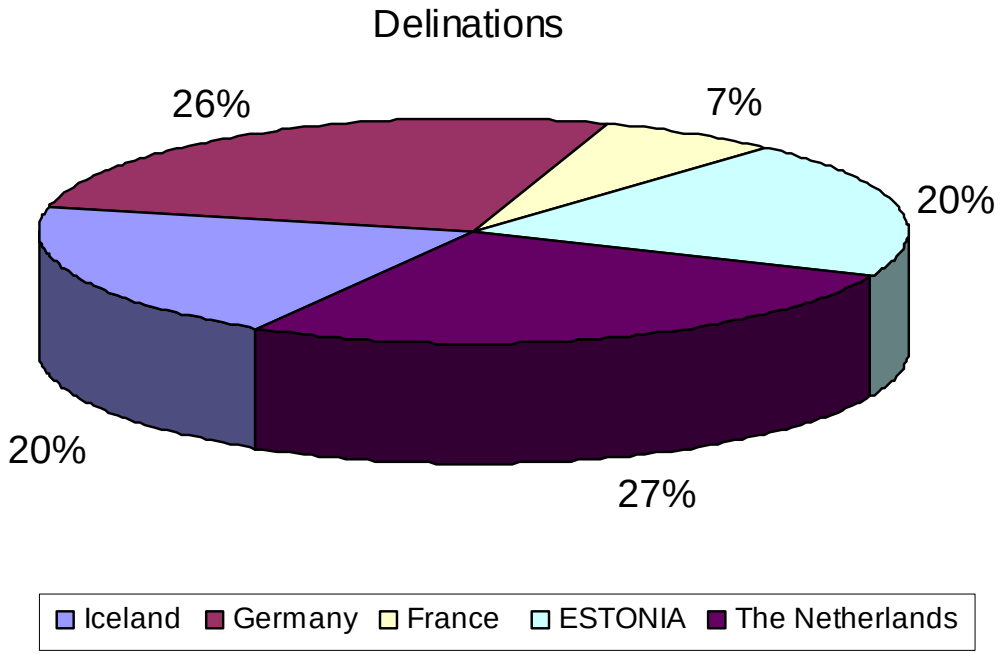
CONTRIBUTE PERCENT OF SINGLE COUNTRY TO TYPE OF INTERVENTIONS FOR ALL TYPE OF ROADS



CONTRIBUTE PERCENT OF SINGLE COUNTRY TO TYPE OF INTERVENTIONS FOR ALL TYPE OF ROADS



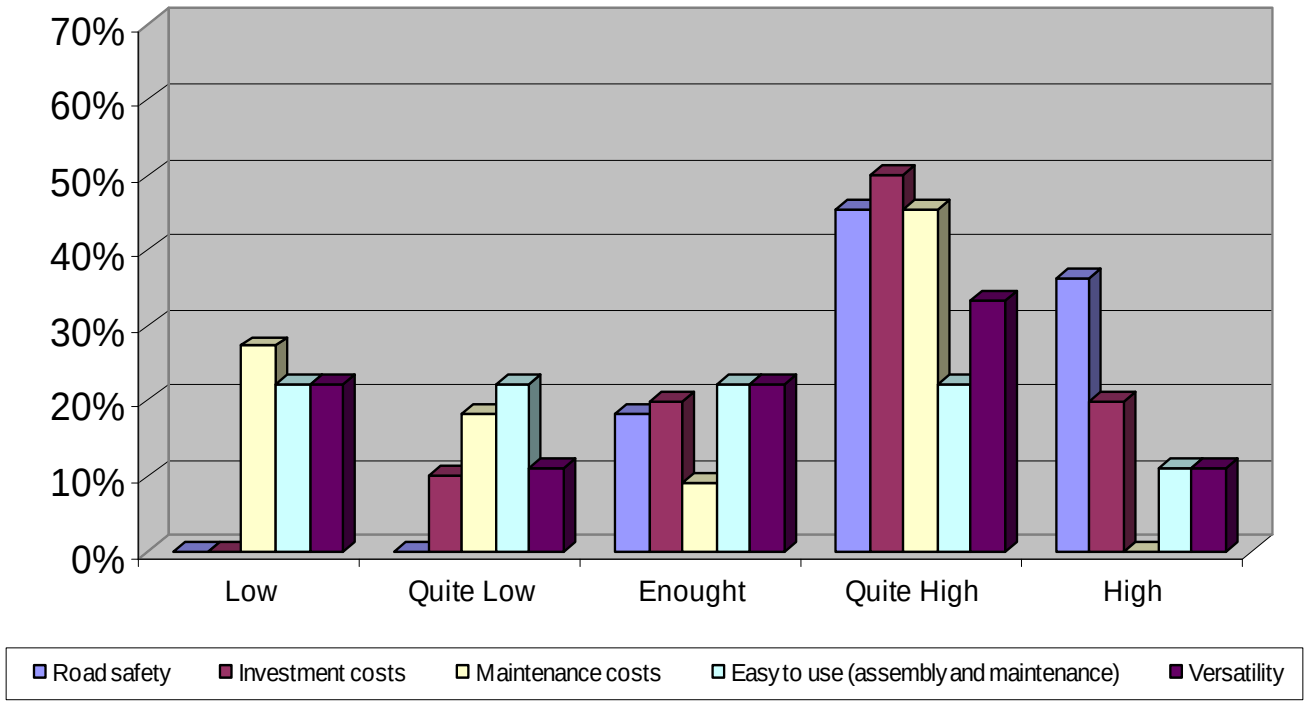
CONTRIBUTE PERCENT OF SINGLE COUNTRY TO TYPE OF INTERVENTIONS FOR ALL TYPE OF ROADS



HOW DO YOU ASSESS EACH ROADSIDE INTERVENTION IMPLEMENTED ON YOUR NETWORK?

(1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

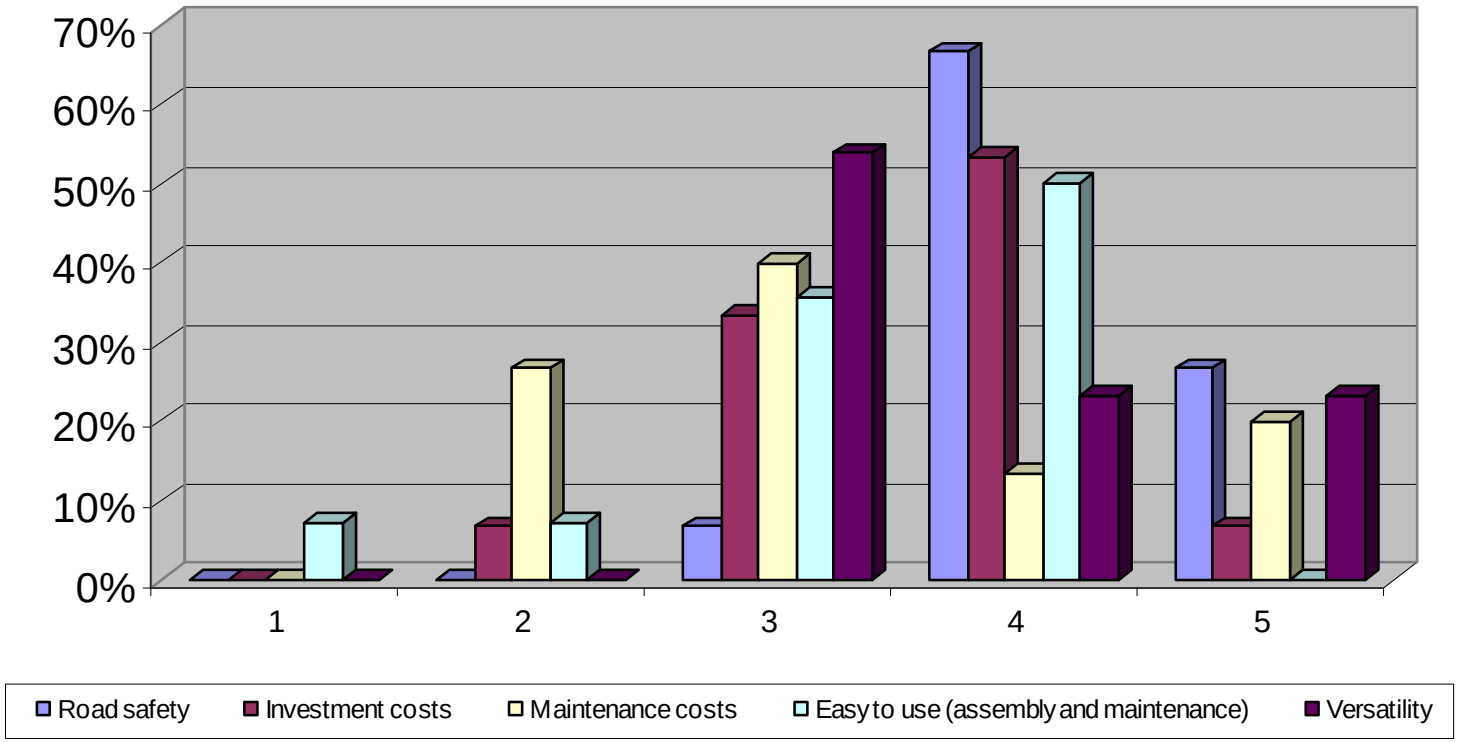
Concrete guard rails for all countries



HOW DO YOU ASSESS EACH ROADSIDE INTERVENTION IMPLEMENTED ON YOUR NETWORK?

(1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

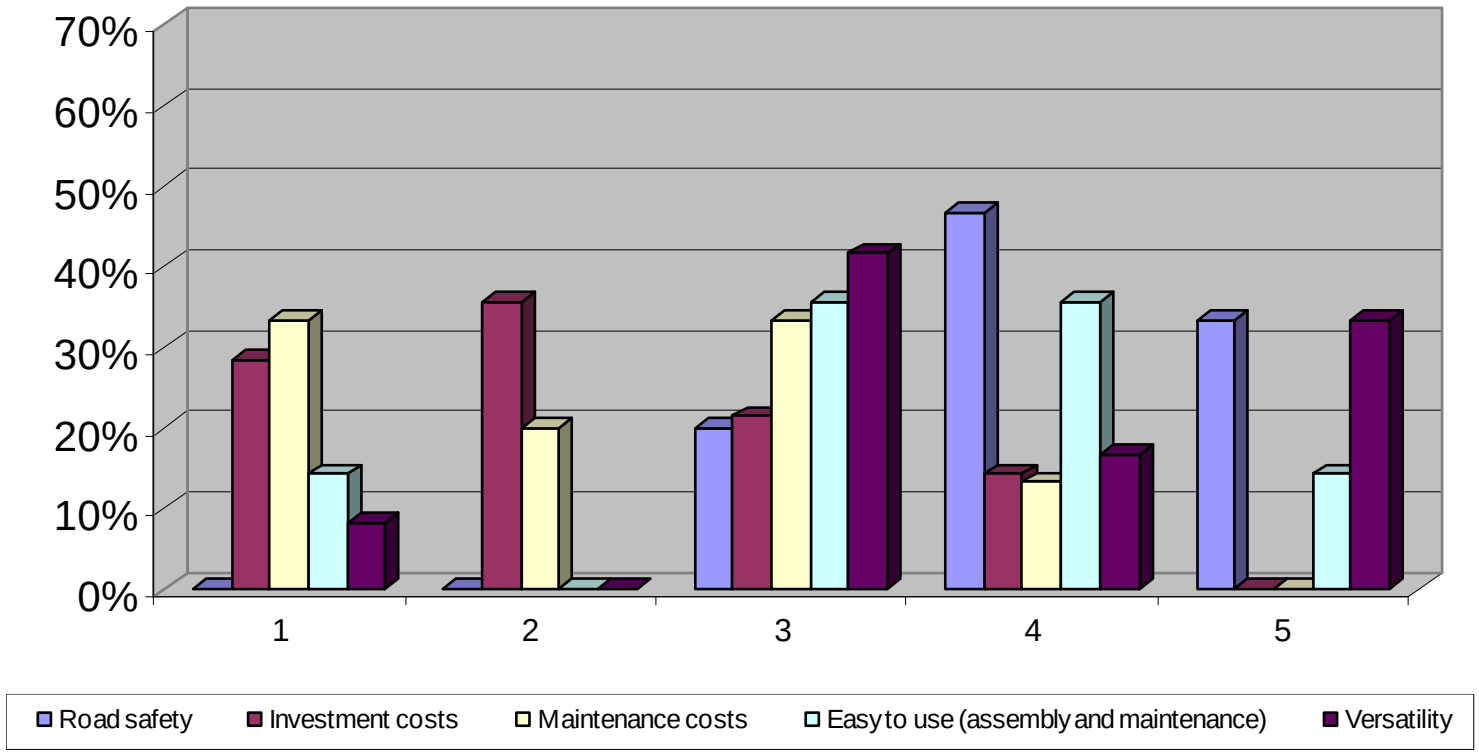
Steel guard rails for all countries



HOW DO YOU ASSESS EACH ROADSIDE INTERVENTION IMPLEMENTED ON YOUR NETWORK?

(1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

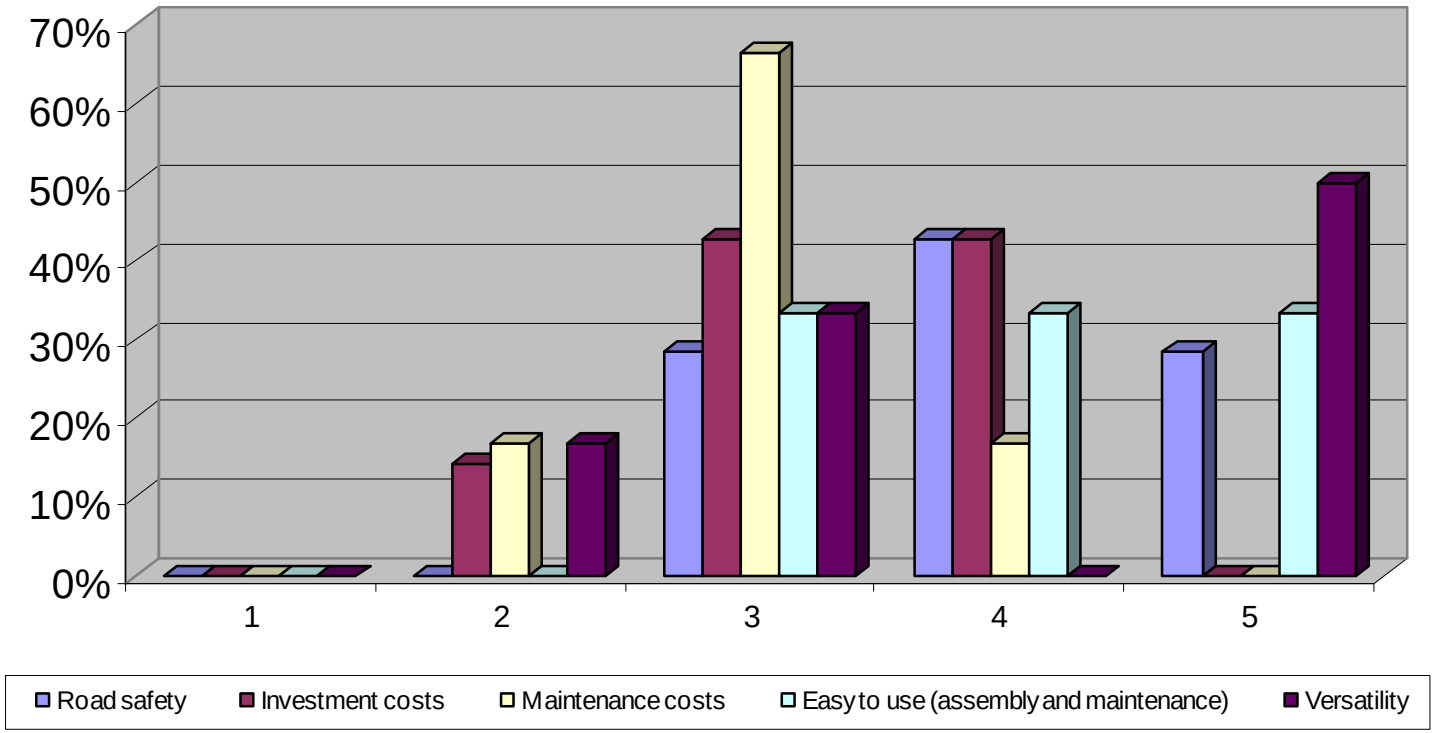
Horizontal signs for all countries



HOW DO YOU ASSESS EACH ROADSIDE INTERVENTION IMPLEMENTED ON YOUR NETWORK?

(1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

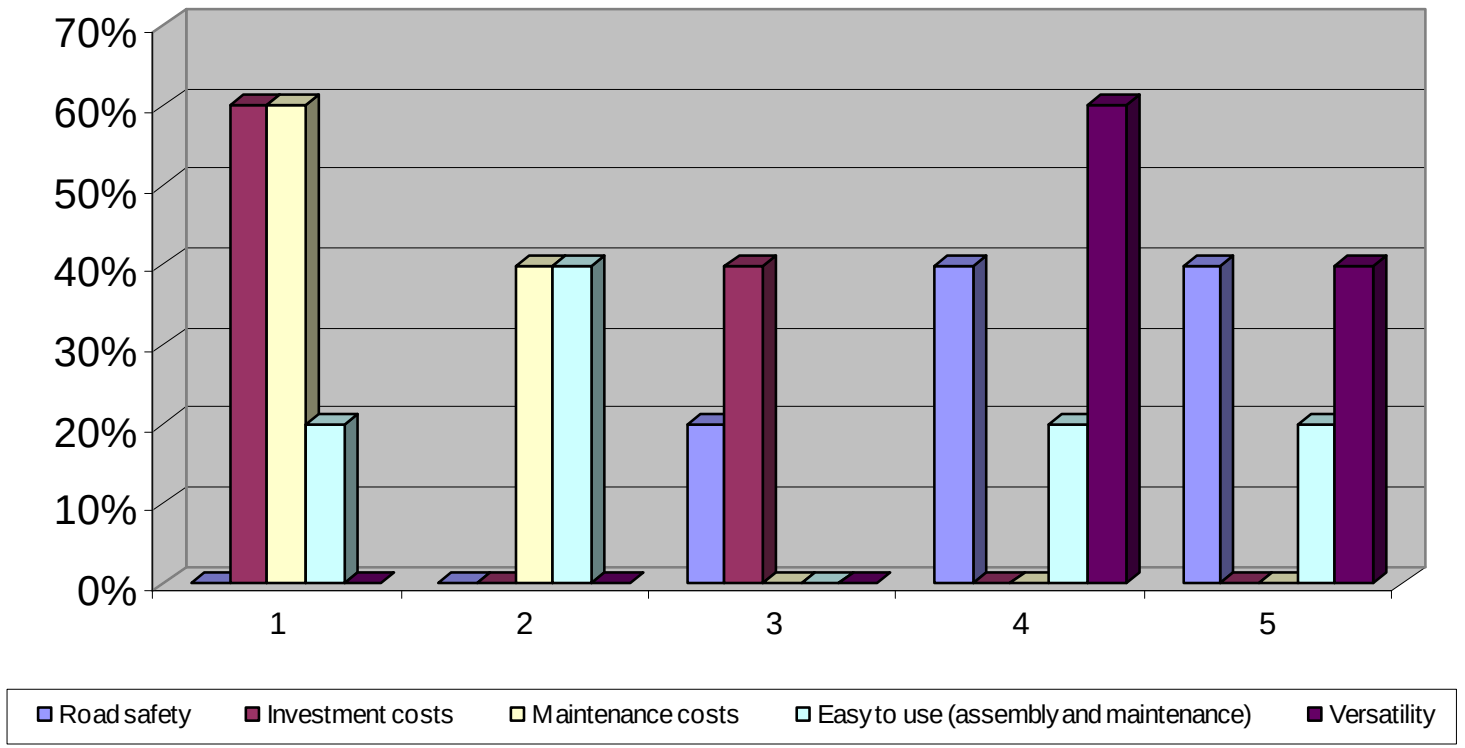
Vertical signs for all countries



HOW DO YOU ASSESS EACH ROADSIDE INTERVENTION IMPLEMENTED ON YOUR NETWORK?

(1 = low; 2 = quite low; 3 = enough; 4 = quite high; 5=high)

Delination rails for all countries



NEW DEVELOPMENTS AND FUTURE SYSTEMS

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

NEW DEVELOPMENTS AND FUTURE SYSTEMS

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

Safety at the Heart of Road Design

Cross-border funded Joint Research Programme

PRESENTATION N°7

Introduction to the interactive discussion on the guidelines

(Francesca La Torre, UNIFI : francesca.latorre@unifi.it)

THE DESIGN GUIDELINE

In the recent years several projects have been conducted to produce guidelines to design forgiving roadsides (both in Europe and in the USA) and several national standards have been produced but different approaches are proposed. The final results of Trans-National Research Projects, aimed at identifying harmonised solutions, are often extremely scientific but not practical and result in a lack of applicability.

THE DESIGN GUIDELINE

Based on the results of WP1 and WP2, this WP of IRDES will produce a practical Guideline that, thanks to the contribution of ANAS and to the interaction with Road Administrations and Operators (through the Round tables and Workshops and through the synergy with the TG on Road safety of CEDR), could be applied in practice in safety design projects. **The different proposed interventions will be linked to the potential effectiveness defined in WP2 in order to allow the user to perform cost-effectiveness evaluation before planning a given treatment**.

THE DESIGN GUIDELINE

One of the issues will be the harmonisation of different existing standards or the identification of underlying reasons for different existing solutions for the same treatments in order to allow the user to select the proper design treatment and to properly assess its effectiveness. A very broad category of interventions (as “terminal treatments” or “installing breakaway poles”) often leads to very broad ranges of possible effectiveness and results in a lack of practical usability of the models. The proposed treatments will also be related to the preventive evaluation of the safety conditions of the existing road (to be performed in agreement with the Directive 2008/96/EC on Road Infrastructure Safety Management).

STARTING POINTS

D06: European Best Practice for Roadside Design: Guidelines for Roadside Infrastructure on New and Existing Roads

RISER

Project ACRONYM: RISER

TITLE: Roadside Infrastructure for Safer European Roads

PROJECT START DATE: 01/01/2003 DURATION: 36 months

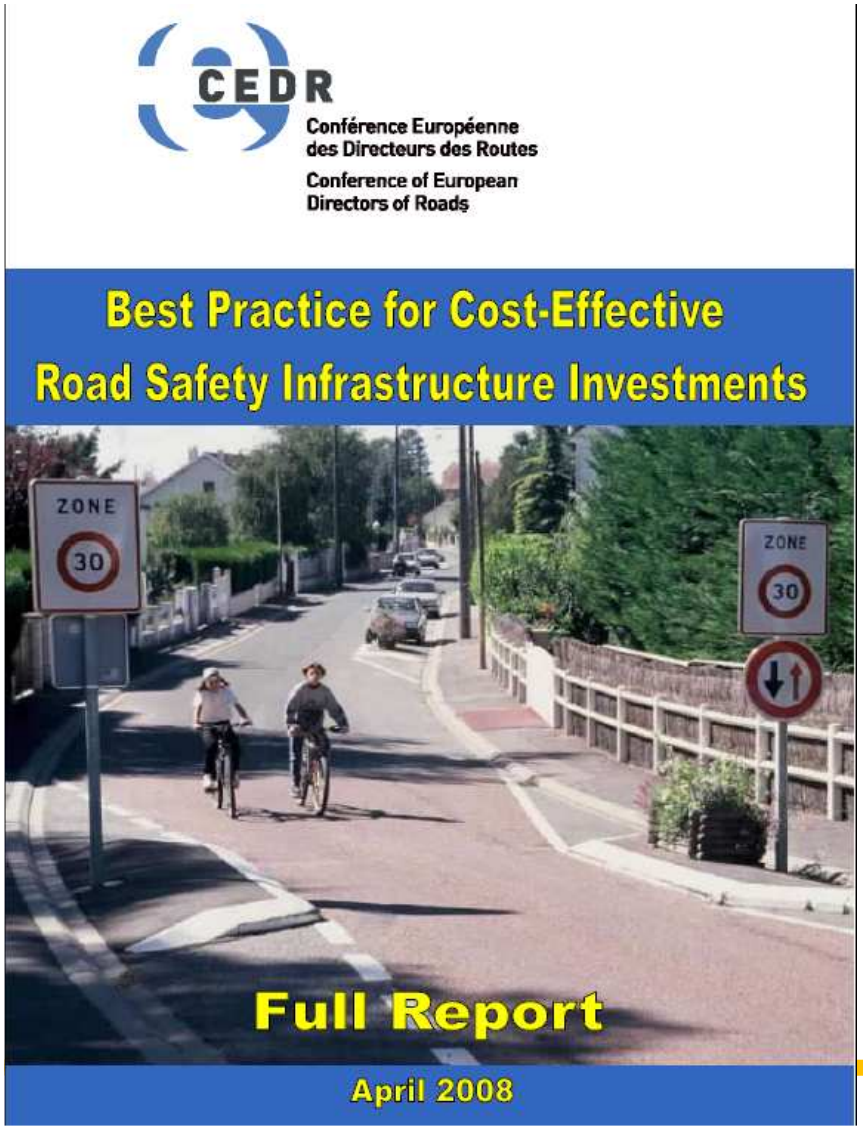
Date of issue of this report: 16/02/2005
Released by Chalmers University of Technology on behalf of the RISER Consortium

Project funded by the European Community under the 'Competitive and Sustainable Growth' Programme (1998-2002)

RISER Project: very good literature review specifically devoted to roadsides

Served as a basis for D1 on literature review

STARTING POINTS



Investment: roadside treatment
Network: mainly interurban / rural
Sub-investments: (not considered separately)
- establishment of clear zones
- flattening side slopes
- installation of safety barriers along embankments
- replacement of safety barriers to meet the EN 1317 standard
- median safety barriers on divided highways / undivided highways
- combination of safety barrier installation and roadside obstacle removal

Maximum safety effect:
- installation or replacement of safety barriers (-47%)
  - especially when combined with other roadside works.

Minimum (or negative) safety effect:
- flattening side slopes (-22%)
  - especially from 1:4 to 1:6 on two-lane undivided roads

Max. C-B ratio*:
- safety barriers, considering only safety effects 32:1

Min. C-B ratio*:
- safety barriers, considering only safety effects 8.7:1

Implementation costs per unit:
- installation of safety barriers € 130,000 – € 220,000 per km, depending on type

Other effects:
- negative effects on environment in some cases (e.g. tree removal)
- slight increase in average speed

Strengths:
- significant safety effects on the number of accidents with casualties, but also on accident severity
- validated cost-effectiveness
- high acceptability by road users

Weaknesses:
- relatively high implementation cost
- side effects on the surrounding environment/landscape
- slight increase in the number of damage-only accidents in some cases

Implementation barriers:
- potentially long and complicated administrative and financial procedures

STARTING POINTS

Source	Clear zones	Side slopes	Safety barriers	Description	Country / Region	Road network: Urban	Road network: Rural	Road network: Highways	Road network: Number of sites	Evaluation method: meta-analysis	Evaluation method: before/after	Safety effect (%): Best estimate	Safety effect (%): 95% conf.int.	Safety effect (%): run-offroad and head-on accidents	Safety effect (%): single vehicle run-off accidents	Safety effect (%): single vehicle accidents with trees	Safety effect (%): all accidents	Safety effect (%): fatal accidents	Safety effect (%): injury accidents	Safety effect (%): Material damage accidents	Safety effect (%): fatalities	Safety effect (%): Injuries
Corben et al, 1997	●			Marking of roadside obstacles	Australia	-	-	-	-		●	-23	s.s.						●			
Corben et al, 1997	●			Removal of roadside obstacles	Australia	-	-	-	-		●	-2	s.s.						●			
Zeeger et al., 1988	●			Increase of the roadside clear recovery distance on two-lane rural roads (between 1,5m - 6,2m)					-		●	(-13;-44)	s.s.	●								
ROSEBUD, 2005	●		●	Setting-up safety barriers and cutting trees	France		●		26,5 km		●	-95	(-59;-99)			●						
Elvik and Vaa, 2004		●		Flatten side slope from 1:3 to 1:4 mostly on two-lane roads	USA		●		-	●		-42	(-46;-38)						●			
Elvik and Vaa, 2004		●		Flatten side slope from 1:3 to 1:4 mostly on two-lane roads	USA		●		-	●		-29	(-33;-25)							●		●
Miaou, 1996		●		Flatten side slope from 1:3 to 1:4 mostly on two-lane roads			●		-	●		-28	s.s.		●							
Elvik and Vaa, 2004		●		Flatten side slope from 1:4 to 1:6 mostly on two-lane undivided roads	USA		●		-	●		-22	(-26;-18)						●			
Elvik and Vaa, 2004		●		Flatten side slope from 1:4 to 1:6 mostly on two-lane undivided roads	USA		●		-	●		-24	(-26;-21)							●		●
Miaou, 1996		●		Flatten side slope from 1:4 to 1:6 mostly on two-lane undivided roads			●		-	●		-24	s.s.		●							
Allaire et al., 1996		●		Flatten side slopes			●		60	●		(-3;-50)	-		●				●			
CEDR (Questionnaire 2)			●	Setting-up safety barriers along embankments	FR				8			-17	-									
CEDR (Questionnaire 2)			●	Setting-up safety barriers along embankments	FR				8			-18	-									
CEDR (Questionnaire 2)			●	Setting-up safety barriers along embankments	NL				-			-50	-									
CEDR (Questionnaire 2)			●	Setting-up safety barriers along embankments	NL				-			-50	-									
CEDR (Questionnaire 2)			●	Setting-up safety barriers along embankments	ES				-			-11	-									
CEDR (Questionnaire 2)			●	Setting-up safety barriers along embankments	ES				-			-49	-									
CEDR (Questionnaire 2)			●	Setting-up safety barriers along embankments	ES				-			-26	-									
Elvik and Vaa, 2004			●	Setting-up safety barriers along embankments	USA, AUS, SE		●	●	-	●		-44	(-54;-32)									
Elvik and Vaa, 2004			●	Setting-up safety barriers along embankments	USA, AUS, SE		●	●	-	●		-47	(-52;-41)									
Elvik and Vaa, 2004			●	Changing safety barriers	USA, AUS, SE		●	●	-	●		-41	(-66;+2)									
Elvik and Vaa, 2004			●	Changing safety barriers	USA, AUS, SE		●	●	-	●		-32	(-42;-20)									
Elvik and Vaa, 2004			●	Median safety barrier on divided highways	USA, GB, FR, SE, DK			●	-	●		-43	(-53;-31)									
Elvik and Vaa, 2004			●	Median safety barrier on divided highways	USA, GB, FR, SE, DK			●	-	●		-30	(-36;-23)									
Carlsson et al., 2001			●	Wire median safety barrier on undivided highways	SE			●			●	-23	-									●

s.s: statistically significant

STARTING POINTS

THE ROADSIDE FEATURES THAT WILL BE CONSIDERED

SHOULDER WIDTH (in combination with lane width; paved Vs unpaved?)

BARRIER TERMINALS (flared Vs energy absorbing)

BREAKAWAY POLES (ONLY LITERATURE)

RUMBLE STRIP (grooved rumble strip in the shoulder, outside the edge line).

POSSIBILE STRUCTURE OF THE GUIDE

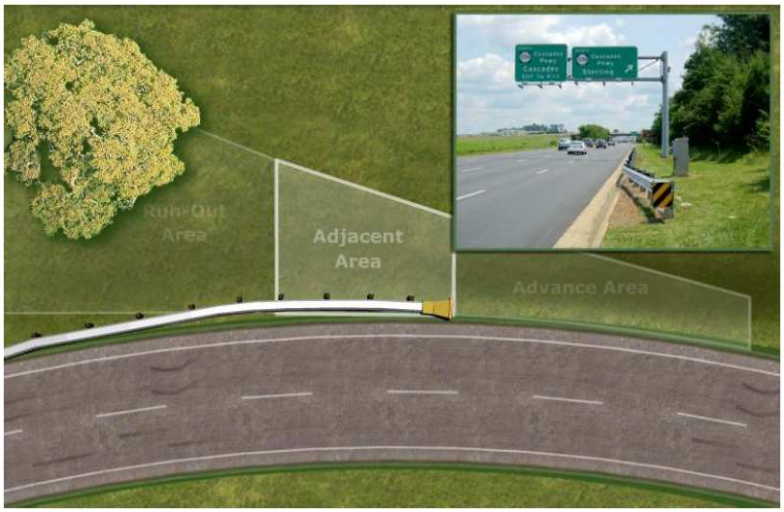
- INTRODUCTION

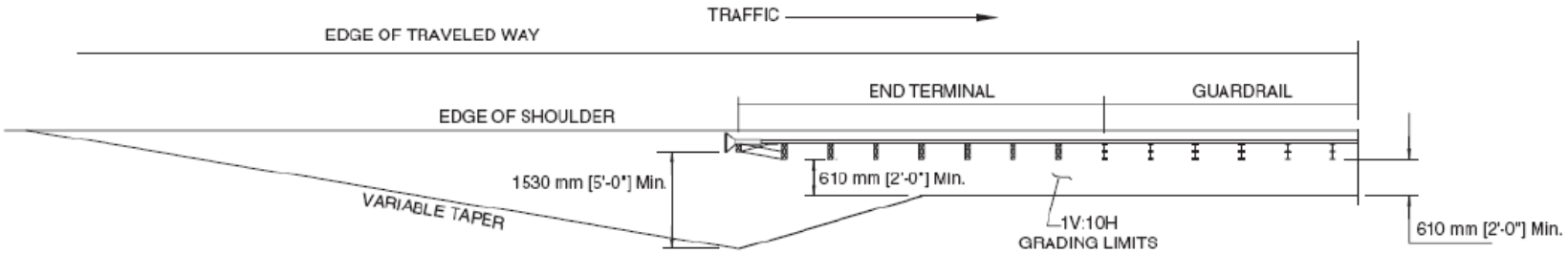
- SECTION 1: TREATMENT/FEATURE ********
  - Design criteria (for different type of roads and configurations);
  - Assessment of effectiveness;
  - Case studies/Examples(?);
  - References divided in:
    - Design guidelines and standards;
    - Effectiveness studies

- SECTION 2: TREATMENT/FEATURE ********
  - Design criteria;
  - Assessment of effectiveness;
  - Case studies/Examples(?);
  - References divided in:
    - Design guidelines and standards;
    - Effectiveness studies

IT SHOULD BE ……

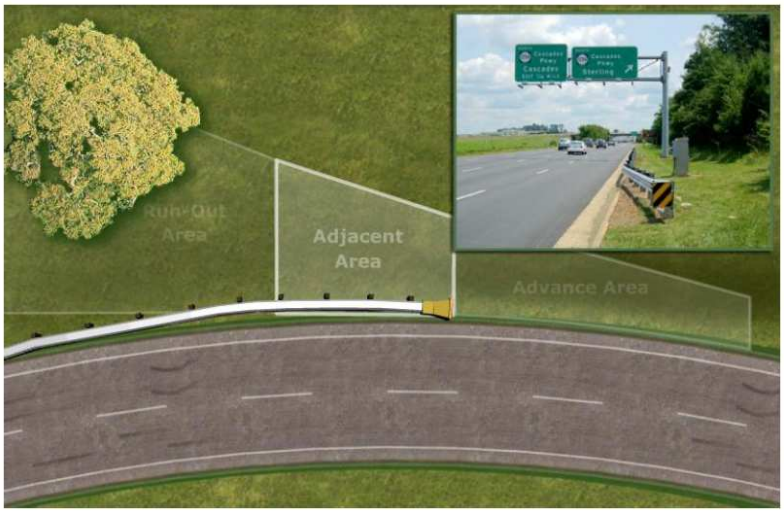
EASY TO UNDERSTAND



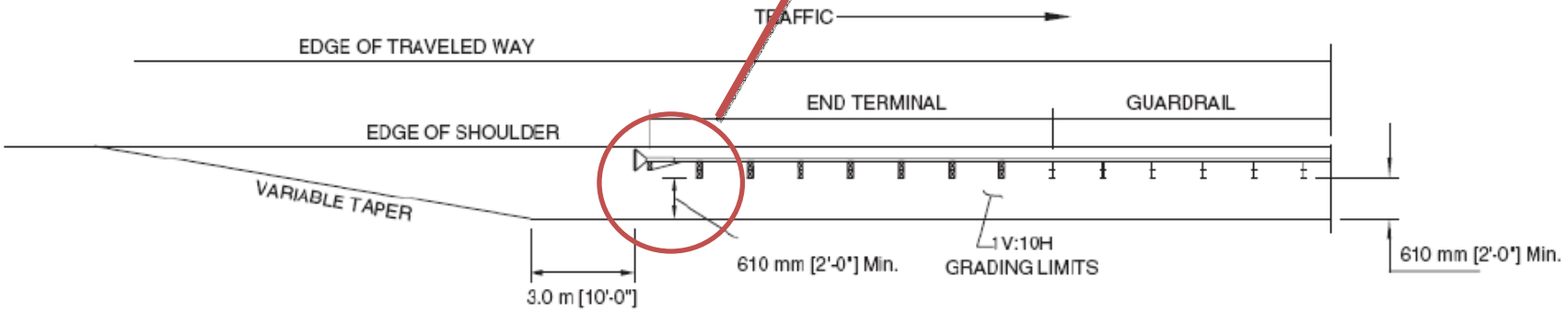


IT SHOULD BE ……

ACCOUNTING FOR “NON OPTIMAL” SOLUTIONS



60 cm instead of 150 cm



ALTERNATIVE GRADING

IT WILL NOT BE

- A BARRIERS DESIGN GUIDE;
- A LITERATURE REVIEW