Tyre and Road Surface Optimisation for Skid Resistance and Further Effects

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Report on policies and standards concerning skid resistance, rolling resistance and noise emissions

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Abbreviations

Abbreviation	Meaning
CEN	Comité Européen de Normalisation (European Committee for Standardization)
CPB	Controlled Pass-By (measurement of tyre/road noise)
CPX	Close ProXimity (measurement of tyre/road noise)
DWW	Dienst Weg- en Waterbouwkunde
OSCAR	Optimum Surface Contamination Analyser and Recorder
PFT	Pavement Friction Tester
PSV	Polished Stone Value
RoadSTAR	Road Surface Tester of Arsenal Research
ROAR	Road Analyser and Recorder manufactured by Norsemeter
SCRIM	Sideway-force Coefficient Routine Investigation Machine
SKM	Seitenkraftmessverfahren
SFT	SAAB Friction Tester
SMTD	Sensor measured texture depth (a measure of texture depth of a road surface based on the root mean square of the texture profile measured with a laser displacement sensor)
SPB	Statistical Pass-By (measurement of tyre/road noise)
SRM	Stuttgarter Reibungsmesser
TRT	Tatra Runway Tester
WG	Working Group

Definitions

Term	Definition
Friction	Resistance to relative motion between two bodies in contact. The frictional force is the force that acts tangentially in the contact area.
Horizontal force (side force)	Horizontal force acting perpendicular to a freely-rotating, angled test wheel.
Longitudinal friction coefficient (LFC)	Ratio between horizontal force (drag) and vertical force (load) for a braked wheel in controlled conditions. This is normally a decimal number quoted to two significant figures.
Macrotexture	Deviation of a pavement from a true planar pavement with characteristic dimensions along the pavement of 0.5 mm to 50 mm, corresponding to texture wavelengths with one-third-octave bands including the range 0.63 mm to 50 mm centre wavelengths.
Mean profile depth	Descriptor of macro texture, obtained from a texture profile measurement as defined in EN ISO 13473-1 and EN ISO 13473-2.
Megatexture	Roughness elements with a horizontal length of 50 to 500 mm. Roughness of this magnitude can influence accumulations of water on the pavement surface (for instance, in unevenness).
Microtexture	Deviation of a pavement from a true planar pavement with characteristic dimensions along the pavement of less than 0.5 mm, corresponding to texture wavelengths with one-third-octave bands and up to 0.5 mm centre wavelengths.
Side force coefficient	Ratio between the vertical force (load) and horizontal force (side force) in controlled conditions. This is normally a decimal number quoted to two significant figures.
Skid resistance	Characterisation of the friction of a road surface when measured in accordance with a standardised method.

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Executive Summary

Increasing traffic and decreasing resources demand sustainable management of road traffic infrastructure. To assure nationwide or even EU-wide uniform levels of certain road surface parameters, policies have been issued that set limits on the levels of these parameters: upper limits (in the case of noise) or lower limits (in the case of skid resistance). To achieve these levels, different strategies have been developed – and these strategies differ throughout Europe and can even vary within individual single countries.

The aim of this report is to give an overview of the current state of policies for skid resistance, rolling resistance and noise emissions in Europe. The extent of existing policies varies in many respects. For noise emissions, regulations have been issued both by the European bodies and individual member states. For skid resistance, the only policies that exist are national; most of them are listed in Annex II to this report. Rolling resistance is a mainly untouched field in terms of policies.

The main part of this report is the documentation of current practices at both EU and national levels. One purpose of this report was to attempt to identify the various policies and then to distinguish between the different approaches used and investigate the reasoning behind them. Therefore, for all three fields, questionnaires were designed and sent out to project partners and their contacts in their respective countries and those of other European partners. Literature surveys have been carried out to summarise the underlying standards and foundations of the different policies. A workshop has been carried out to discuss the ideas of policies with a wider expert audience. The results of the workshop are incorporated in this report.

Policies concerning skid resistance

The European Union has not yet implemented a harmonized policy regarding skid resistance. Four European countries analysed do not have any policy regarding skid resistance at all. The others have at least a policy for a specific road category. Especially on the low-level road networks, the number of EU countries having a policy declines. The policies concerning skid resistance are mainly set by road authorities, though the road operator or national research institutes are involved in some countries. For motorways and primary roads, the majority of EU countries have introduced policies or standards which are legally enforceable.

There are several international standards for specific skid resistance measurement methods and devices. In total, 15 different skid resistance measurement devices were listed by the questionnaire respondents (work elsewhere in TYROSAFE has identified some 23 different types of device in regular use in Europe). The pendulum (SRT) is mentioned in most policies as a local measurement device. It is mainly used as a complement to mobile skid resistance measurement devices and is used for local investigations or research tool. SCRIM or SKM (Seitenkraftmessverfahren) is used by nine EU countries; the GripTester follows with eight countries using it. Generally, the longitudinal measurement principle (used by 12 EU countries) is more common than the transverse principle (nine EU countries). However, some countries use a combination of devices based on different principles.

Individual road crashes, routine monitoring or accident cluster analysis can trigger skid resistance measurements. The number of EU countries doing routine monitoring related to skid resistance policies decreases markedly towards the low-level networks. Fourteen of seventeen EU countries routinely monitor their motorway and primary road network. The monitoring frequencies vary from twice a year to every fifth year. Mostly, the measurements for routine monitoring are made between spring and autumn. However, in some northern countries routine monitoring is done in winter, even on icy roads.

Skid resistance of roads can be classified by defining threshold levels. These levels are based on different indices or coefficients describing the measured skid resistance. The analysis found that there were many differences among the respondents in the number of levels, the values and the dependencies on measurement speed, weather and road type. Nevertheless, standardized thresholds are commonly defined for high-level road networks.

On newly built roads, their ability to provide sufficient skid resistance is verified in many countries by carrying out acceptance tests. These measurements are mainly done a few weeks after road opening. If the acceptance test fails, most EU countries take measures to improve the skid resistance. Additionally, placing warning signs, deducting money and imposing speed limits are common measures.

While warranty periods are very common in other fields, this issue does not have a high importance in skid resistance policies. Less than fifty percent of all EU countries require warranty tests. Perhaps this is because routine monitoring is carried out anyway.

Policies concerning rolling resistance

Rolling resistance is one of the two main environment-related aspects of tyre/pavement interaction (the other being noise emission). It is directly linked with fuel consumption and therefore with the CO_2-emission of a vehicle driving on a road surface.

According to the results of the literature review and the questionnaire, there are currently no policies or standardised measurement methods anywhere in Europe in regard to tyre rolling resistance on different road pavements.

As well as reviewing policies for rolling resistance itself an assessment of the parameters of the road that potentially influence rolling resistance have been investigated. The most important of these are macrotexture, megatexture and evenness. To date, research has not agreed on the relative extent of the influence of these factors on rolling resistance.

Several measurement devices for assessing rolling resistance are described in this report, distinguishing between static measurement units (drums) and dynamic measurement units (usually trailers).

Finally, ISO 18164 is described in detail.

Policies concerning noise emissions

Road/tyre noise, the second environmental apect of tyre/pavement interaction, has been regarded as a significant nuisance for a long time. Consequently, considerable effort has been devoted to setting legal rules over the recent years. The European Directive

2002/49/CE relating to the assessment and management of environmental noise gives a legal framework for road noise mitigation. In parallel, two Directives specify the type approval tests of vehicles and tyres, and set legal limits for their noise emission. These regulations are completed by a set of international standards describing the measurement methods of noise emission or its contributors.

Because tyre-road noise is the dominant source of noise from vehicles travelling above relatively-low speeds (around 30 km/h for passenger cars and 50 km/h for trucks), road surface characteristics play a major role in the road noise generation. Low-noise road surfaces significantly and beneficially reduce road traffic noise in addition to other abatement measures, such as speed reduction and noise barriers. However, the lack of legal rules or common procedures for the classification and the assessment of noise properties of road surfaces is considered to be a serious limit on further development of low noise road surfaces at the European level. Procedures for road surface type testing (or labelling) and for the check of Conformity of Production (COP) are active in some EU countries or are under consideration in several others, but none of them is comparable. This is demonstrated from a literature review and is confirmed by a survey that was conducted during the project.

Furthermore, a significant effort has been made during the past ten years for the development of standardised methods for road noise measurements, but more has to be done to make them more reliable and more applicable.

A harmonised system of characterisation of noise properties of road surfaces is necessary for the promotion of low noise road surfaces, a relevant technique for road traffic noise mitigation. It is also noted that low-noise properties are compatible with high skid resistance properties, and presumably low or reasonable rolling resistance.

1 Introduction

Throughout European countries, different scales of standardization exist for skid resistance, rolling resistance and noise emissions on roads. The TYROSAFE project, a Coordination Action funded by the European Commission under the Seventh Framework Programme aims at coordinating and preparing for European harmonisation and optimisation of the assessment and management of essential tyre/road interaction parameters to increase safety and support the greening of European road transport. This work will performed in the following six work packages (WP):

- WP1: Policies of EU countries for skid resistance / rolling resistance / noise emissions
- WP2: Harmonisation of skid-resistance test methods and choice of reference surfaces
- WP3: Road surfaces properties – skid resistance / rolling resistance / noise emissions
- WP4: Environmental effects and impact of climatic change – skid resistance / rolling resistance / noise emissions
- WP5: Dissemination and raising awareness
- WP6: Management

The goal of this deliverable is to show the current extent of different policies, standards and measurement techniques concerning skid resistance, rolling resistance and noise emissions. Primarily, information about the EU member states has been gathered.

Chapter 3 deals with policies and standards that are implemented to ensure that new and for existing roads skid resistance provide appropriate skid resistance. The results of a survey of skid resistance policies in the EU member states are presented.

In Chapter 4, current standards for rolling resistance measurements are shown and existing measurement methods are summarized.

Policies concerning noise emissions are dealt with in Chapter 5. Current methods for the evaluation of road noise and related aspects have been reviewed. It includes reference to standards and European legislation. A review of current national practices regarding classification and assessment of road surfaces is also made, with the help of a survey. Further needs and some recommendations for a reasonable practice are also discussed in this chapter.

Finally, the report concludes by identifying the gaps in present regulations and by summarizing common standards throughout Europe. This provides a basis for developing recommendations for future harmonised EU policies concerning skid resistance, rolling resistance and noise emissions, the next phase of this Work Package in TYROSAFE. A list of references to existing standards is included as Annex II to the report.

2 Scope

2.1 Definition

The term “policy” has no exact definition. The on-line encyclopaedia, Wikepedia, suggests than in general a policy is “a plan of actions to guide decisions and achieve rational outcomes”.

In terms of road surface properties, policies are set up to ensure that appropriate levels of skid resistance, rolling resistance or noise are provided or maintained. A policy can be a formal written document or a loosely connected bundle of directives, even non-written best practices could be regarded as some kind of policy.

In this report, therefore, both formal policy documents and informal arrangements that provide a framework for managing the three main properties have been considered.

2.2 Methodology

It was clear from the outset that the status of policies and standardization of skid resistance, rolling resistance and noise differs widely across Europe. This has led to different approaches to documenting the work done to cover the three topics and hence to varying structures in the chapters of this report that describe them. For skid resistance, a separate literature review concerning the influence of skid resistance on road safety and accident risk has been carried out. Although research work in this field is not directly connected to the policy and standardisation work, this topic often serves as an underlying basis for policies. Therefore, the results of the literature review are presented in Annex I of this report.

To gather initial information on policies relating to the three surface properties, two questionnaires were prepared, one for skid resistance (which as a topic was expected to be generally more advanced) and a combined one covering both noise emissions and rolling resistance. The purpose of the questionnaires was to build a reasonably detailed overview on national practices, measurement methods and standards used across Europe.

In addition to the questionnaire survey, a workshop on current practices was organized in conjunction with SURF2008 conference in Portorož, Slovenia. Topics of discussion were the “why” and “how” of the national approaches, how the national approaches had changed over time and how satisfied people are with the current situation. There were 25 participants, predominantly technical experts, from 16 countries (both EU- and non-EU) at this event, providing opinion and experience in the three topics. The findings of this workshop have been incorporated into the respective topic chapters.

3 Skid resistance

Skid resistance is the ability of paved surfaces to offer resistance to skidding or slipping [1]. Problems with skid resistance mainly occur when the road surface is wet. Acceleration, deceleration and steering actions can only be made under control, if the road surface offers at least the same level of grip as the driver's action requires [2]. Throughout Europe, therer are different approaches to the provision of appropriate levels of skid resistance on roads. Current regulations and standardization efforts are reviewed in the following chapters.

3.1 Influence of skid resistance on road safety

3.2 Current policies and standards in the EU

There are different extents of skid resistance policies throughout European countries. To date, the European Union (and its respective bodies the European Commission, European Parliament and Council of the European Union) has not issued formal policies on skid resistance. Directive 2008/96/EC on road infrastructure safety management considers the improvement of skid resistance as one measure to improve safety on high accident concentration sections. Interpretative document No. 4 ("Safety in Use") for the Council Directive 89/106/EEC states „The process and the conditions for the measurement of skid resistance and the polished stone value have to be harmonized". The establishment of classes for both characteristics has to be considered" in conjunction with the risk "Accident resulting from vehicle movement". Nevertheless, at present there is no harmonized process for dynamic skid resistance measurement (see also deliverable D04 and D05) and no harmonized policy on skid resistance. Possible ways forward towards a future harmonized EU wide policy will form part of the TYROSAFE Deliverable D08.

A policy often relies on underlying standards: Table 3-1 summarises different topics that are appropriate for policies and those that are topics for standards.

Table 3-1: Differences between policy and standard for skid resistance

Policy	Standard
Application area of devices	Measurement principle
Monitoring intervals	Technical specifications of devices
Threshold levels	Calibration of devices
Measures to be taken if values are below threshold	

Throughout Europe, the extent to which policies have been implemented varies widely. In England, for example, not only is there a policy covering the nationally important major routes operated by central government agencies, many county councils have their own skid resistance policy document covering the roads for which they are responsible. By contrast, in Finland no policy concerning skid resistance exists at all.

But not only does the extent to which policies exist vary widely, both from one country to another and within individual countries, there is as great a variation in relation to the levels of network covered by the policies that do exist. Where some policies only consider motorway networks, other countries have policies down to the tertiary networks and even for urban roads. This will be discussed in more detail later in the report.

What is considered important in each country is reflected in its policy. Here different approaches exist. The most elaborate approach is risk-based in which the skid resistance levels required depend on an assessment of the actual accident risk.

Another approach is to demand a certain skid resistance value for one network ("fixed levels"). The idea behind this is that different levels of network are characterised by the speeds at which vehicles travel. Higher speeds lead to higher stopping distances and therefore need higher friction values. A variation of this approach is to set fixed levels based upon the design speed of a road.

In another approach, rather than set specific levels for skid resistance, measurement values are incorporated into a combined condition index, where other parameters such as rut depth or surface defects are considered as well in assessing the maintenance or other requirements for a road.

A skid resistance policy could contain the following components:

- Devices to be used for pavement monitoring.
- Road network monitoring procedures.
- Thresholds for friction classification and acceptance or warranty tests.
- Measures to be taken if skid resistance falls below a threshold.

Apart from its safety aspect, skid resistance is also a quality of newly built roads that many countries require to be guaranteed. To ensure this quality, acceptance tests and warranty tests are carried out in many countries.

Material specifications have a large effect on skid resistance, so minimum levels of parameters like PSV (polished stone value) can also be part of the policy. As well as factors such as PSV (which relates to polishing of the microtexture and hence loss of skid resistance under the influence of traffic), the macrotexture of the surface also has an indirect influence on skid resistance, especially at higher speeds. A sufficient level of MPD (mean profile depth) or MTD (mean texture depth) is often required and in effect forms part of a skid resistance policy.

3.2.1 Gathering information

A task of WP1 is to review the current position in EU member states concerning skid resistance policies. As well as the countries represented by the TYROSAFE project partners (all part of FEHRL) is was considered important to include countries that did not have highway research laboratories organisations that were members of FEHRL. This would provide greater scope for identifying overlaps and gaps in current policies and for pointing out advantages and disadvantages of current and alternative approaches, to help find a basis for future harmonised EU policies.

To achieve these goals, the following steps have been followed. The first step was to identify countries which should be included in the survey. All those countries, including the 27 EU member states, were divided into groups and allocated to the TYROSAFE project partners. The idea was to use each partner's international contacts in order to make the survey as widespread as possible..

As a second step, a comprehensive questionnaire was designed to collect information about the policies concerning skid resistance in different countries. A single questionnaire would be filled out by each country. Therefore, the choice of an objective expert per country was very important; the forms were only to contain the actual facts about policies.

In the event 17 EU-countries responded with a completed questionnaire and one did not complete a questionnaire but did confirm that they do not have any policies relating to skid resistance. Figure 3-1 shows a map of the responding countries.

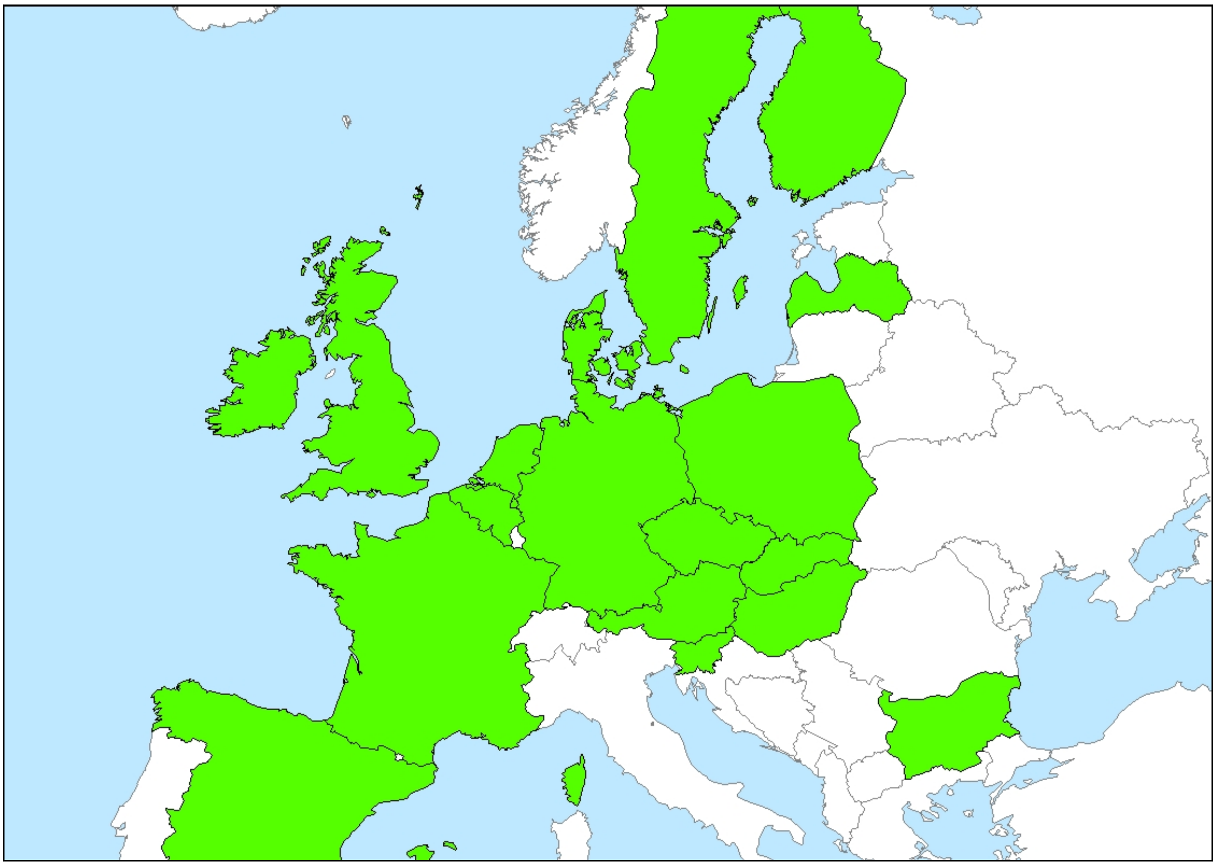


Figure 3-1: EU countries (green) that responded to the questionnaire

While each project partner was distributing the questionnaires to their allocated countries (or completing them on their behalf where they had the necessary knowledge), a database for the evaluation of the completed forms was created. It consists of five tables, which are shown in Annex III. All completed forms are shown in Annex IV. The results of the evaluation of the responses are presented in the following sections.

Information not covered by the questionnaires was gathered through the workshop with experts in the field of skid resistance held in October 2008. The main topics were the motivation behind the application of skid resistance policies and the preparation for a future harmonisation. The findings of this workshop have also been incorporated in the following chapters.

3.2.2 Road categories

The first section of the skid resistance questionnaire dealt with a classification of road categories in order to form a common basis for the subsequent sections. As there is a large variation throughout the countries concerning the administration and operation of roads, a more generic approach was taken to distinguish between road categories. Networks were categorized by their function, as set out in Table 3-2.

Table 3-2: Different road categories

Motorways	- High capacity roads designed to carry fast motor traffic safely - Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway - Access is typically grade-separated and junctions are free-flowing - Some categories of users (pedestrians, cyclists, tractors, …) are not permitted - In many countries, a toll has to be paid for usage
Primary roads	- Major roads linking important local centres - Provide access to motorways - Available to all types of traffic - Typically single carriageway but may have sections of dual carriageway - Can have traffic lights - Usually a distinct numbering system for the whole country is used
Secondary roads	- Roads linking smaller local centres - Usually single carriageway but may have local dual carriageway sections - Provide access to primary roads - No access restrictions - Local numbering system usually not shown along the road
Tertiary roads	- Roads providing local networks or links between smaller towns and villages, typically in rural areas - Not usually in national classification or numbering system - May be single-track in remote areas
Urban roads	- Roads in urban areas - Typically subject to a speed limit of 50 km/h (or equivalent) or less

3.2.3 Overview of policy management

Relating to section 2 of the questionnaire for skid resistance policies, the main issue of this chapter is whether there are any policies or not. If yes, the questions about who sets and controls them are answered here as well. In addition, the different road classes (see Section 3.2.2) have also been evaluated in order to show the extent of policies in different countries.

What is the motivation behind policies?

Motivation behind policies is not easy to cover through a questionnaire survey. The workshop held in conjunction with SURF2008 conference on October 22nd 2008 in Portoroz, Slovenia was intended to find out more about the principles and living practice behind the policy documents. Topics of the discussion were:

- Benefits of policies
- Purpose of policies
- How satisfied stakeholders are with existing polices

The discussion began by considering what the benefit of policies might be. Responses varied markedly as the range of practice became apparent, which ranged from sophisticated policies such as those in use in the UK and New Zealand, through countries that made measurements but did nothing with them, to no policy at all. Those with well established policies recognised benefits in reduced accidents, reduced risks of litigation and cited examples where improved skid resistance, especially at high risk locations, had markedly reduced the number of crashes. In some countries, the relevance of this aspect seems to be higher than in other countries. Even though the direct connection of a particular skid resistance level to accidents is difficult to measure, there has been a lot of research work on this topic (see Annex I).

Sustainability is also an issue that gains more and more importance and it was mentioned that skid resistance policies are very important for the tyre industry.

Discussion raised an interesting question - if there are different road authorities in a country, do the policies also differ? In New Zealand and the United Kingdom, problems occurred following the adoption of existing policies and then applying them to another road category and/or different road authority. The main issue is the adequate incorporation of existing policies into a system with different constraints. If a policy has been applied for motorways, several aspects of this policy have to be reconsidered if an application for another road category is planned.

Adoption of such a policy leads to the issue of harmonisation. The challenge here is to find a skid resistance policy for different countries that can be applied by all authorities involved. For example, the Northern European countries have different requirements concerning skid resistance on roads. Obviously, it is senseless to apply a policy adapted for the influence of winter conditions in southern regions.

It should be mentioned that not only the harmonisation methods, but also the general need for harmonised policies was discussed in the workshop. There was a sense that moving towards a harmonised approach could be useful. However, the majority of those present were technical experts rather than policy makers and so it was difficult to judge what the policy implications in different countries might be. It is proposed to take this aspect further at a second workshop in March 2009. At that event, invited participants who plan or advise on policy development will be presented with the findings of this report and then asked take a more strategic view of possibilities for moving towards a harmonised approach to policies across Europe.

How many countries have any kind of policy?

Four of the 18 responding EU-countries[1] do not have any policy for skid resistance at all, although they have devices for friction measurements. In Figure 3-2, the shares of countries with and without policies are shown for each road category.

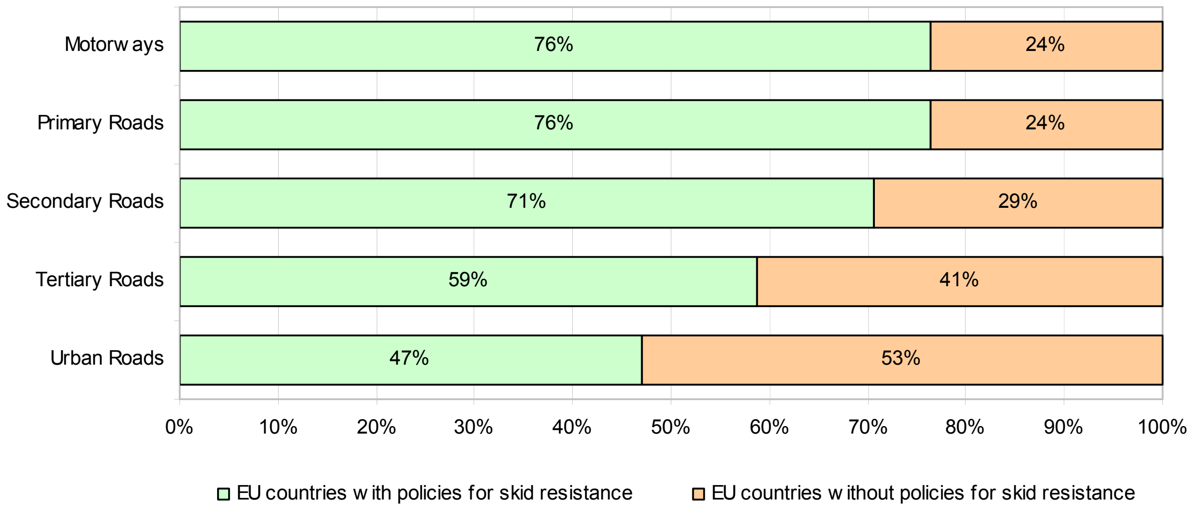


Figure 3-2: Shares of EU countries with and without policies for skid resistance per road class

The number of EU countries having a policy decreases towards urban roads. At least 13 EU countries have policies for motorways and primary roads whereas only eight have regulations for urban roads. For tertiary roads, no policies exist in nearly the half of the countries responding.

Policies are usually issued by road authorities. In some countries, the road operator is also involved. In some countries, national research organisations are involved.

[1] This number includes Finland, who did not complete a questionnaire, but confirmed that they have no policy.

How many countries measure skid resistance?

Apart from any policy regarding skid resistance, the question whether the countries make skid resistance measurements anyway has been evaluated and Figure 3-3 shows the results.

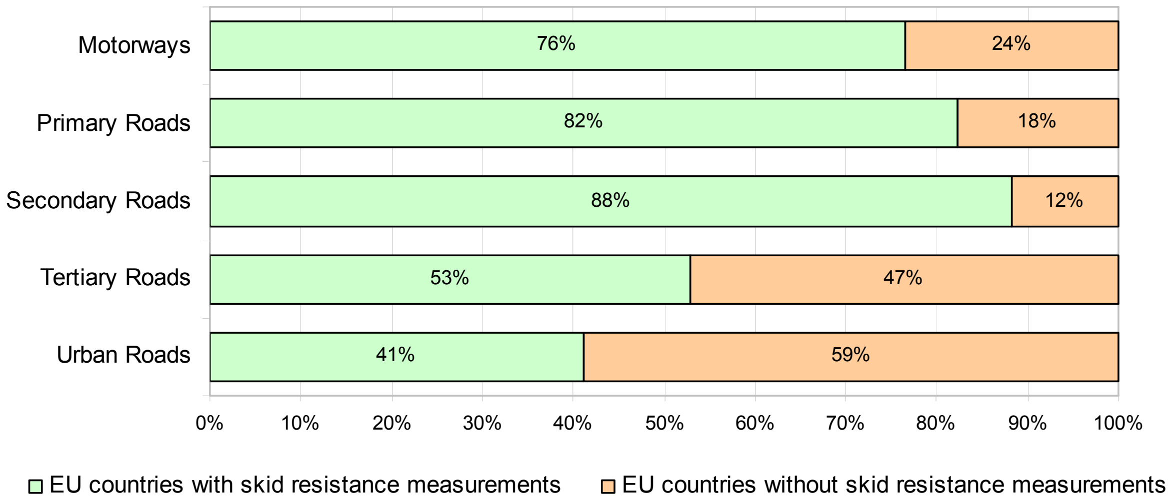


Figure 3-3: Proportions of EU countries with and without skid resistance measurements

On higher-level networks, skid resistance measurements are more common. On secondary roads, measurements are made in 15 of the 17 EU countries completing a questionnaire. What cannot be seen from this chart is the extent of measurements. Having answered "yes" for a road category does not that mean the whole network is monitored regularly.

Several other measures are used to control skid resistance. Besides the devices that directly measure the skid resistance, material specifications, including factors such as aggregate PSV, are used to control friction provision. In some countries, micro- and macrotexture measurements are carried out as well.

What is the legal status of the policies?

The legal status of a policy is of major importance since this is likely to influences the rigour with which it will be applied in practice. With the introduction of tolls on high level networks, demands for road safety and comfort have increased. If a policy is legally enforceable, it demands highly standardized and well documented road maintenance.

Figure 3-4 shows the road classes broken down by legal status of the policies in the various countries. The high level networks show the greater level of implementation. On motorways, the policies or standards are legally enforceable in ten countries. The standards mainly represent best practice on primary and secondary roads, while the legally enforceable standards decline towards the lower network levels. The unknown status means that no answer was given in the questionnaire.

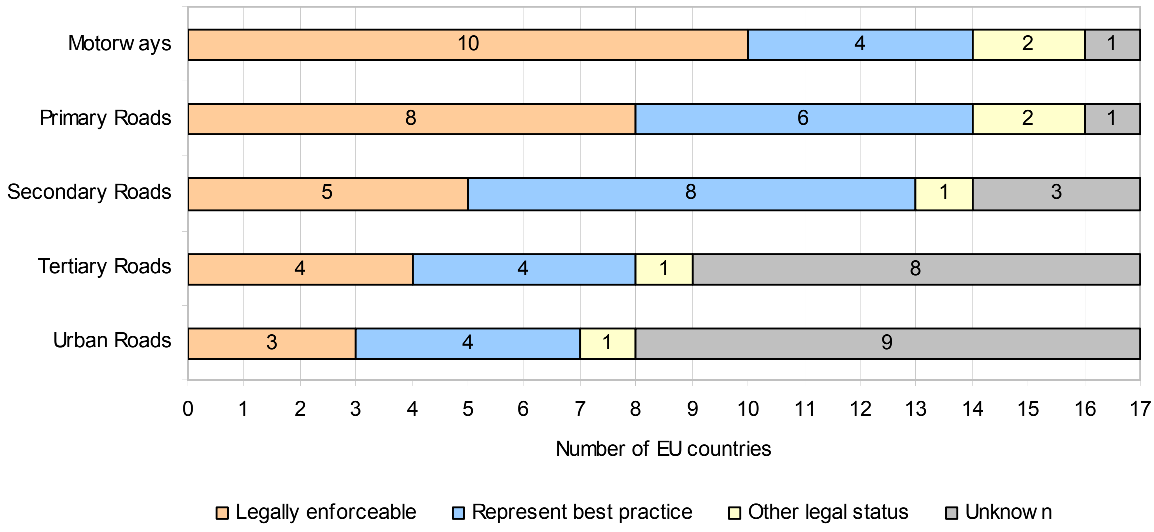


Figure 3-4: Proportions of EU countries according to the legal status of the standards, by network level

3.2.4 Skid resistance measurement methods and devices

This section of the report deals mainly with the methods and devices used for skid resistance measurements in the various countries and describes the underlying operating standards. It also explains where, when and why those devices are used. TYROSAFE Deliverable D04 “Report on state-of-the-art of test methods” describes the individual devices in some detail.

Which measurement devices are most common?

Figure 3-5 summarises the numbers of countries using each of the 15 different devices listed to measure skid resistance. SCRIM and SKM are very similar devices, operating on the same principle with the same general configuration (See Deliverable D04 for more details) and for this reason they are grouped together in this analysis.

It can be seen that the Pendulum (Skid Resistance Tester) is used by most of the respondent countries. The Pendulum is the only internationally standardized skid resistance measurement device. Therefore, it features in most skid resistance policies. This is a static device, however, unsuitable to network monitoring and for this reason it is discussed separately in this report and is excluded from the subsequent analysis. Even though its weaknesses are well known, the Pendulum can be used as local complement to the larger mobile dynamic skid resistance measurement devices. For localised investigations, where larger machines are unsuitable, it is still in use.

The mobile and dynamic measurement systems are led by SCRIM/SKM and GripTester. All other devices are only used in one or two EU countries. Figure 3-6 and Figure 3-7 show the geographical distribution of the countries using the main four types of device.

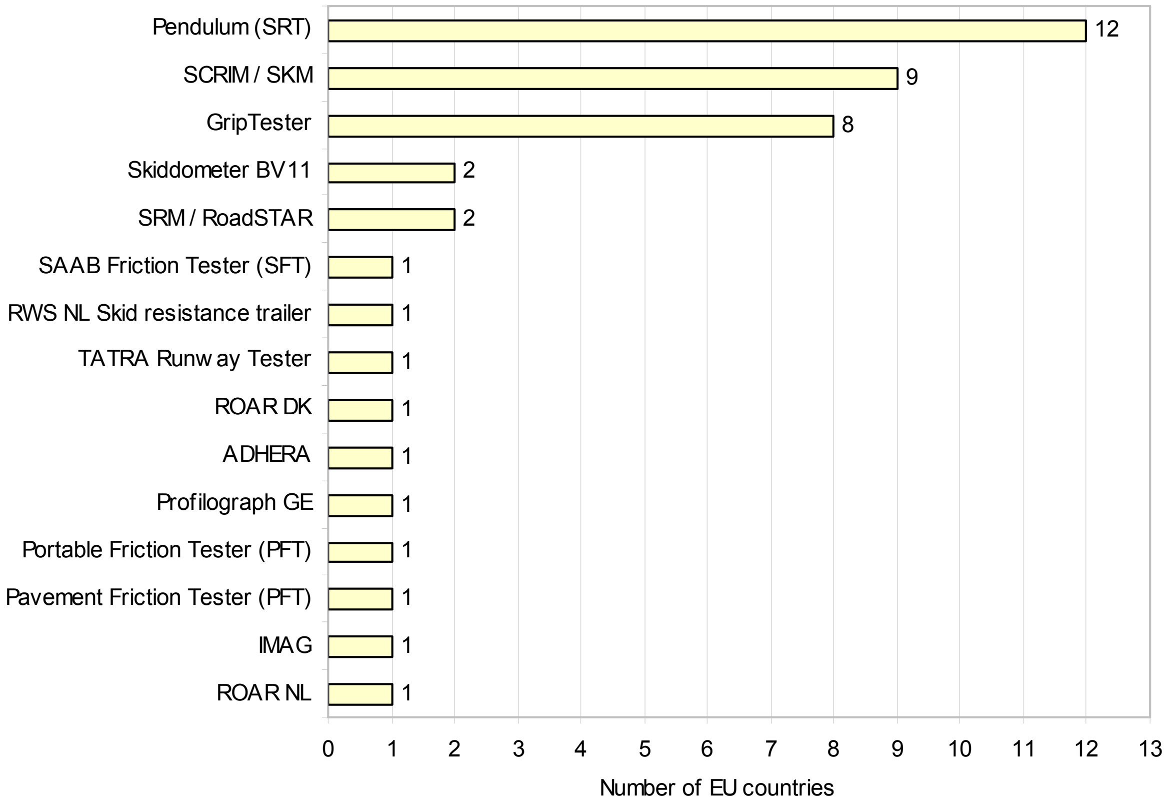


Figure 3-5: Skid resistance devices and the number of EU countries using it

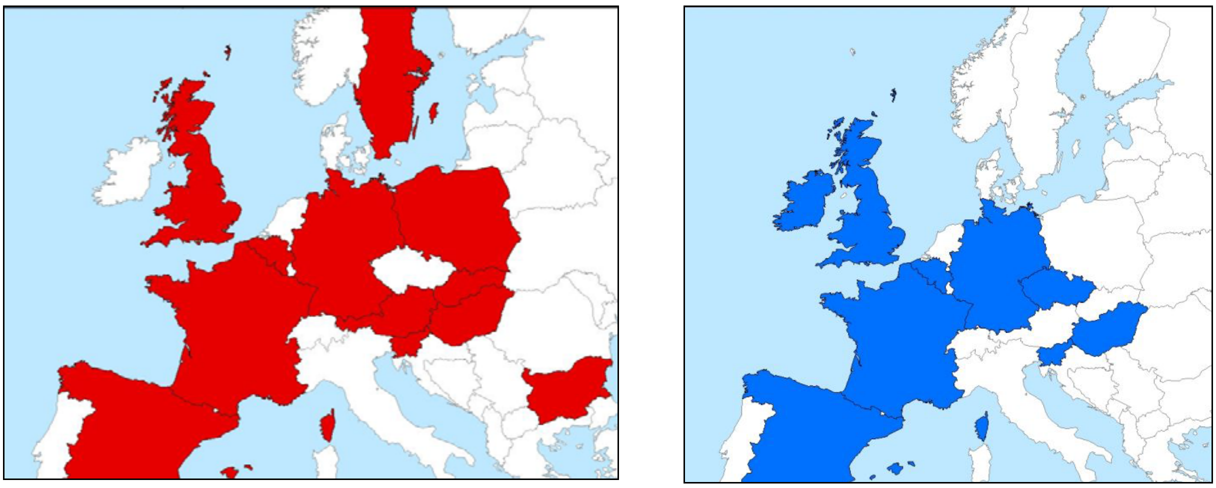


Figure 3-6: EU countries using the Pendulum (left) and SCRIM/SKM (right)

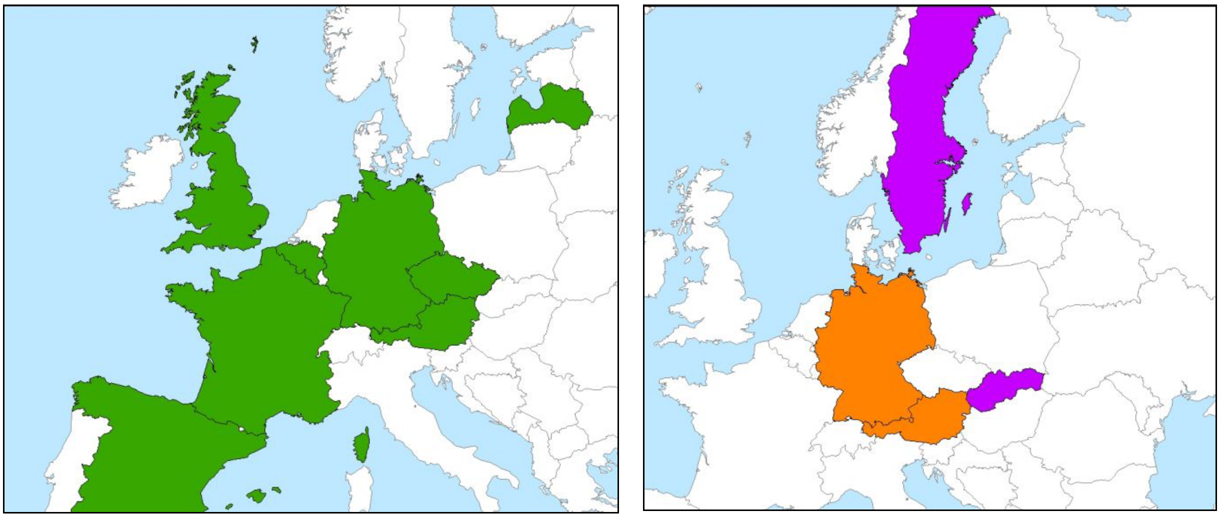


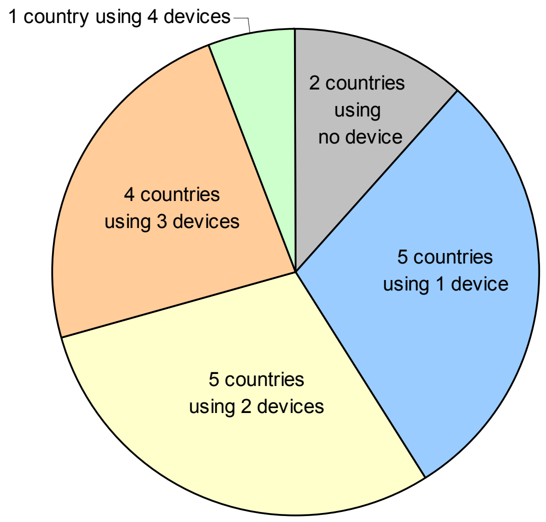
Figure 3-7: EU countries using the Griptester (left), the SRM/RoadSTAR (right, orange) and the Skiddometer BV11 (right, purple)

How many devices are used per country?

Figure 3-5 shows all devices that are used throughout the European Union[2]. However, the majority of countries use more than one device. The pie chart in Figure 3-8 shows the proportion of EU countries using different numbers of devices and the net diagram shows the numbers of devices used in individual countries.

Twelve of the responding EU countries use at least two skid resistance devices besides the pendulum. Only France uses more than three devices. The pendulum is not included in these diagrams.

[2] Although this analysis concentrates on the 17 EU countries that responded to the questionnaire, it is known from other contacts that some of the EU countries for which a questionnaire was not completed (Italy and Portugal, for example) use devices from this set and so the analysis is reasonably representative of the EU as a whole.



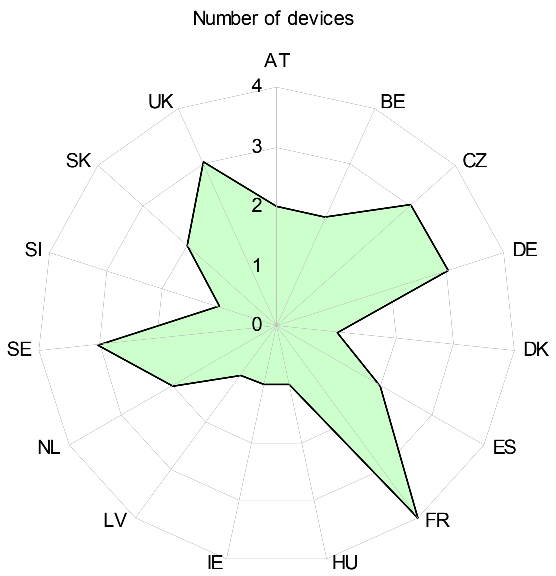


Figure 3-8: Share of EU countries according to the number of skid resistance devices (left) and number of devices for each EU country (right)

Which measurement principles are most common?

The devices used throughout the European Union vary greatly, and consequently the measurement principles used differ as well. TYROSAFE deliverable D04, which reviews the state of the art of skid resistance measurement methods “Report on state-of-the-art of test methods”, classifies devices into three groups depending on the principles used. These three groups are:

1. Longitudinal friction principle.
2. Transverse friction principle.
3. Locally used or slow moving devices.

Analysis of the questionnaires shows that 12 of the 17 responding EU countries use at least one device based on the longitudinal friction principle. Locally-used or slow-moving devices are also used by 12 EU countries. Nine of the 17 countries use at least one device based on the transverse friction principle.

Many countries do not limit themselves to only one of these principles and use one, two or all three, albeit for different purposes. The Venn diagram in Figure 3-9 shows the numbers of countries making measurements using each of the three measurement principles. It can be seen that five EU countries use at least one device in all three categories. Six countries make measurements based both longitudinal transverse friction principles. The diagram illustrates the use of a local or slow moving device to complement one or more of the dynamic devices. The Pendulum is the dominant type of local device, being used in most countries to different extents.

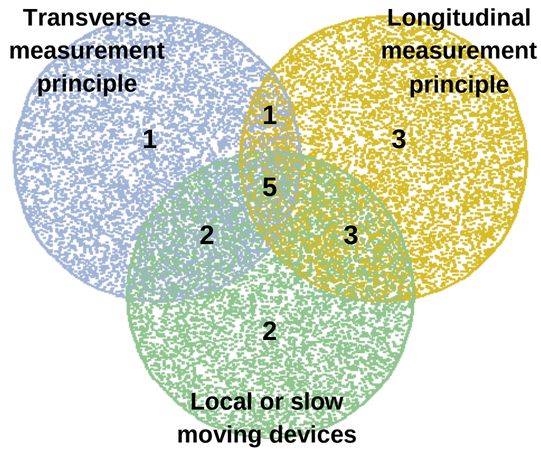


Figure 3-9: Skid resistance measurement principles and number of EU countries applying it

What are the measurement devices used for?

Since several different devices are used in some countries, the questions as to what they are used for is very important. Some devices may be used to support the skid resistance standards in that country whereas others may complement these as a research tool. Figure 3-10 shows the number of EU countries according to the main uses of their devices and Table 3-3 breaks this down by type of device.

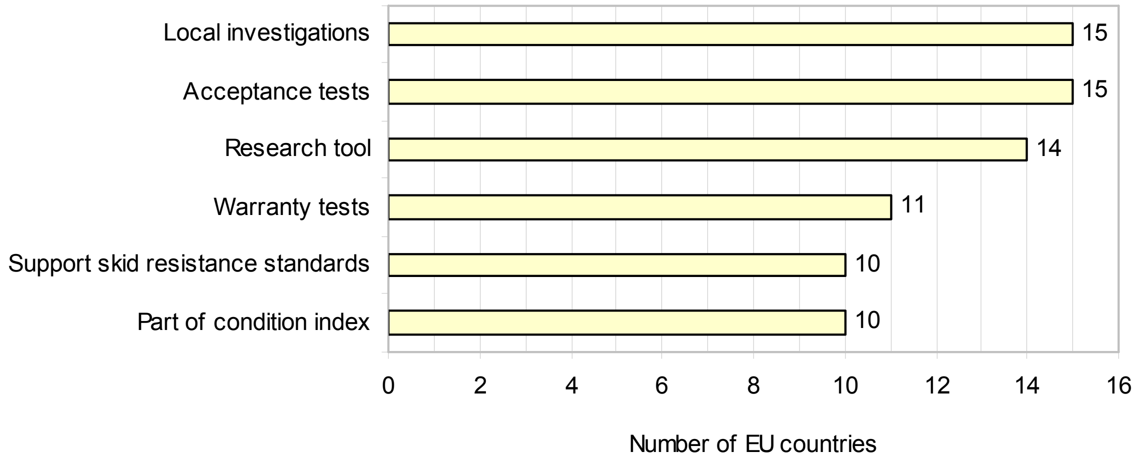


Figure 3-10: Number of EU countries according to different uses of skid resistance measurement devices

15 of 17 EU countries use at least one of their devices for local investigations and Table 3-3 shows that this is the main use for the pendulum tester, again reflecting the common use of the pendulum to complement dynamic devices. SCRIM/SKM and GripTester are often applied to local investigations as well. Only ten countries use at least one of their devices to directly support their skid resistance standards.

Table 3-3: Number of EU countries using skid resistance devices for certain purposes

Device Name	Support skid resistance standard	Part of Condition Index	Local Investi-gations	Research tool	Acceptance tests	Warranty tests
Pendulum (SRT)	1	2	9	7	7	2
SCRIM + SKM	5	3	9	7	7	6
GripTester	1	2	5	6	3	1
Skiddometer BV11	1		2	2	2	2
ADHERA			1	1	1	1
Pavement Friction Tester (PFT)			1	1		
RoadSTAR	1	1	1	1	1	1
ROAR DK + ROAR NL	2		1	2	1	1
RWS NL Skid resistance trailer	1	1	1	1	1	1
SAAB Friction Tester (SFT)			1	1	1	1
Portable Friction Tester (PFT)				1		
Profilograph GE		1				

When looking at the usage of the different devices, noticeable differences can be seen. The pendulum is widely used for local investigations, acceptance tests or as a research tool but its use in a condition index is rare. SCRIM/SKM and Griptester are used in all fields more or less equally. RoadSTAR, Skiddometer BV11 and RWS trailer are all-purpose devices that are used in all mentioned areas as well. The other less-commonly used devices are usually confined to one country: they are almost all used for research and local investigations (which, of course, are akin to research in nature) but further analysis is not appropriate for these.

How is the pendulum test utilised?

The following analysis specifically deals with the Pendulum tester (SRT). This is a commonly-used device, but the measurements are carried out in different ways and the main use varies between different European countries.

In seven of 17 EU countries, the pendulum is used for acceptance or warranty tests. Some countries have regulations that restrict the Pendulum to short sections and use larger devices for longer sections. It is mostly used in areas where it is not possible to measure with a dynamic device like SCRIM/SKM or GripTester. The Pendulum is normally used as a stand-alone measurement device, except in three countries, where an outflow meter is combined with it.

3.2.5 Road network monitoring

The results presented here refer to section 4 of the questionnaire for skid resistance policies. It deals with the standards and common practice for road network monitoring carried out to support the policies summarised in Section 3.2.3 of this report.

How many countries monitor the skid resistance of their road networks?

An important part of the analysis of the questionnaires was to establish the extent to which countries carry out routine monitoring on their networks, or not at all. Figure 3-11 shows the numbers of respondent countries that carry out routine monitoring at the various network levels and those that do not.

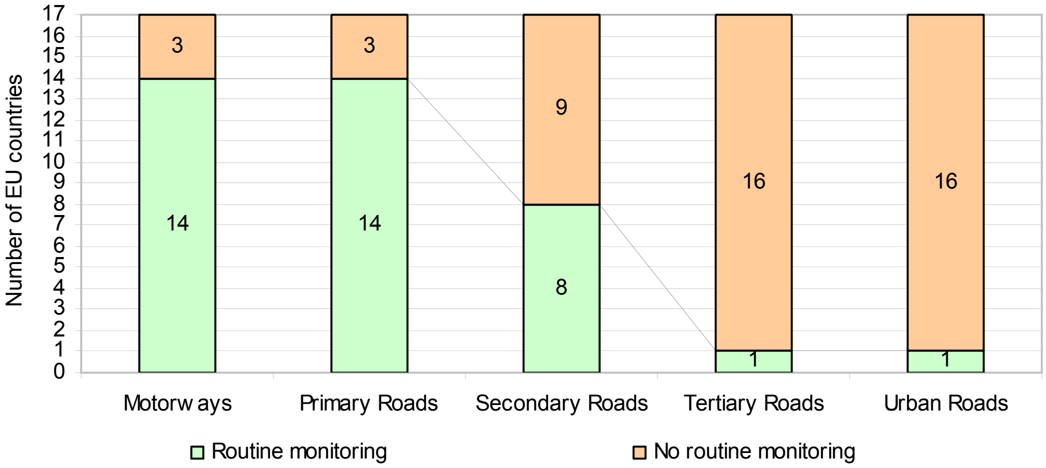


Figure 3-11: Shares of EU countries with and without routine monitoring required by standards, per road class

As was seen with the application of policies, the proportion of countries doing routine monitoring reduces with the network level. Motorways and primary roads are often treated in the same way. On both types of network, 14 of the 17 countries monitor routinely. On urban and tertiary level roads, routine monitoring is not considered important: only one country (Slovakia) reported routine monitoring on tertiary and urban roads.

How often is the network monitored?

In those countries which use routine monitoring relating to policies, the monitoring frequency shows differences across Europe. In Figure 3-12, the different frequencies are illustrated for each road class. On motorways, seven of 14 countries (50%) monitor their network once a year.

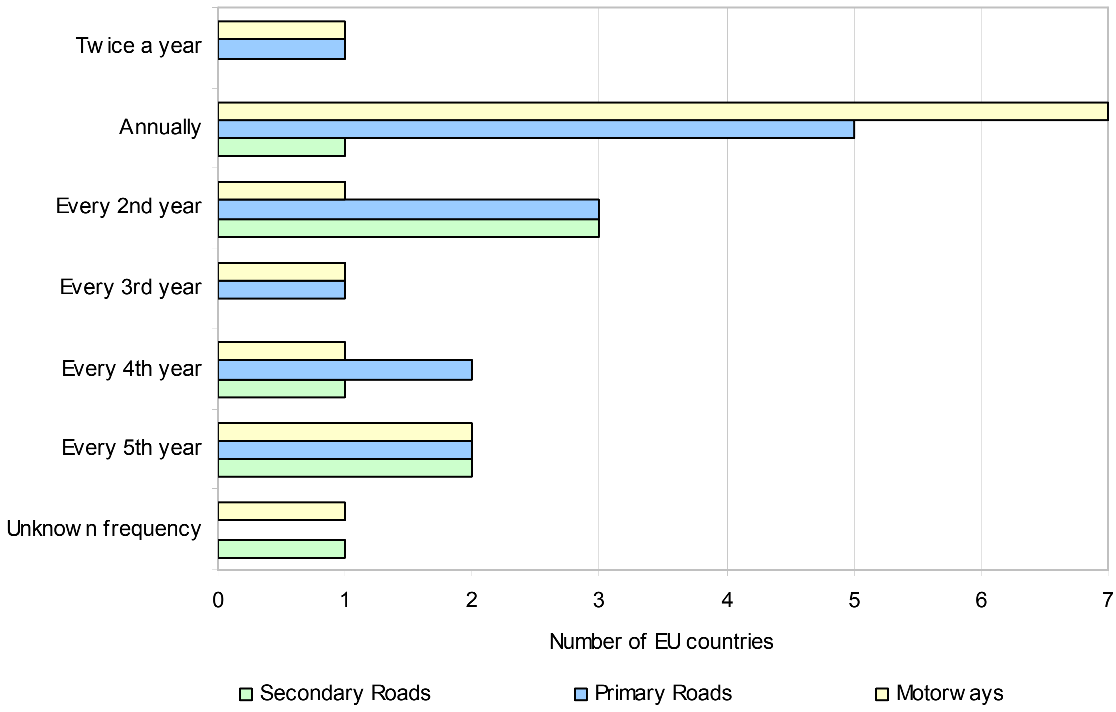


Figure 3-12: Frequency with which EU countries carrying out skid resistance routine monitoring different levels of network

At first glance, higher monitoring frequencies (one or two years) seem to be more common for high-level road networks than for lower ones. However, these frequencies may well depend on the road network lengths. Figure 3-13 deals with this relation for motorways.

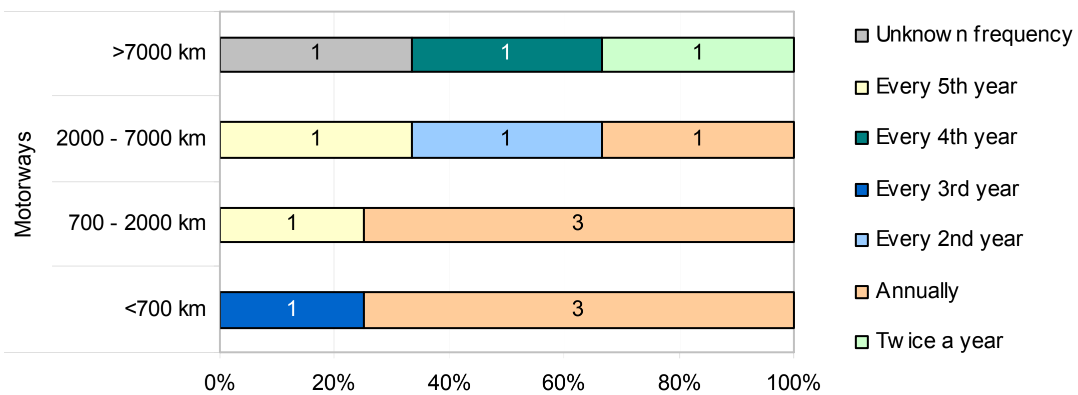


Figure 3-13: Proportion of EU countries carrying out routine skid resistance monitoring on motorways at different frequencies, broken down by network length

The number of countries monitoring their motorways annually decreases as the network length increases. Surprisingly, Spain has a very long motorway network, but monitors the network twice a year. In general it seems that there are no significant links between network length and monitoring frequency for the data available. The total number of countries would need to be analyse that. However, it should be borne in mind that, as well as network length, the number of devices available to make the measurements will be important. If a country has only one device, the length that can be covered will be limited, whereas a larger fleet can monitor greater distances or more often. In the UK, for instance, 14 SCRIMs are available for network monitoring on major roads, with a similar number of GripTesters used by local councils.

Does the routine monitoring have seasonal constraints?

Mostly, the measurements for routine monitoring are made between spring and autumn. In winter, weather conditions and minimum temperature limits for the devices do not allow correct measurements in many countries. However, some countries, especially those in Northern Europe, do make measurements in the winter months. In these countries, where snow and ice on roads is a common condition for a significant period of the year, routine monitoring is done in winter, even on icy roads.

Which direction and lane is monitored routinely?

Although roads may be monitored for skid resistance, it is of interest to know where – or, more specifically, on which lane and in which direction – the routine measurements are made. The questionnaire showed that 85 percent (12 of 14) of the EU countries evaluated measure both carriageways on motorways[3]. On primary roads, half of the respondent countries measure in one direction only.

Most EU countries, (10 of 14) carry out routine skid resistance monitoring on motorways in Lane 1 but four measure every lane. Ramps and links motorway link roads are monitored by six countries.

What else triggers skid resistance measurements?

As well as routine monitoring in relation to pavement maintenance or management, skid resistance measurements can have other triggers. For instance, they can be done on request or as response to road traffic accidents. The results of the analysis of this question are shown in Figure 3-14.

[3] Only the countries whose measurements are made in a routine monitoring programme, are included.

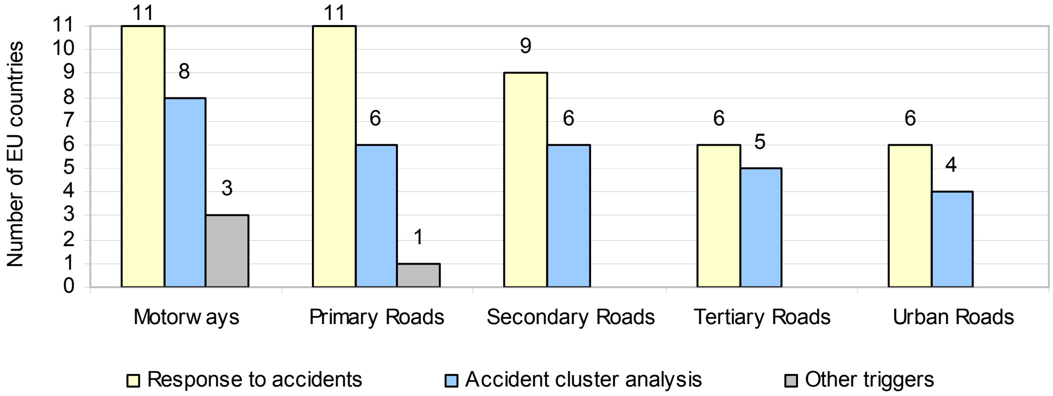


Figure 3-14: Number of EU countries according to different skid resistance measurement triggers, per road class

According to the questionnaire, 11 EU countries measure in response to individual crashes both on motorways and on as primary roads. This could occur as a result of a police request after an accident. Considering the general decrease towards urban roads of countries doing measurements, the similar decrease of the different triggers is not surprising.

3.2.6 Standardized thresholds

This section presents the findings of the survey relating to the way in which skid resistance threshold levels are determined and the roads that they apply to applied in different EC countries. The measures taken when measurement results are below the thresholds differ from country to country.

Where are the thresholds based on?

Before analysing the different threshold levels, it should be clarified where they come from, in particular, whether they are required as a result of applying some kind of policy (as defined in Section 2.1). Figure 3-15 shows whether the local thresholds for each level of network are based on policies or not. These results also include any regulations or standards defining levels to classify road friction. As earlier, the total number of EU countries analysed is 17.

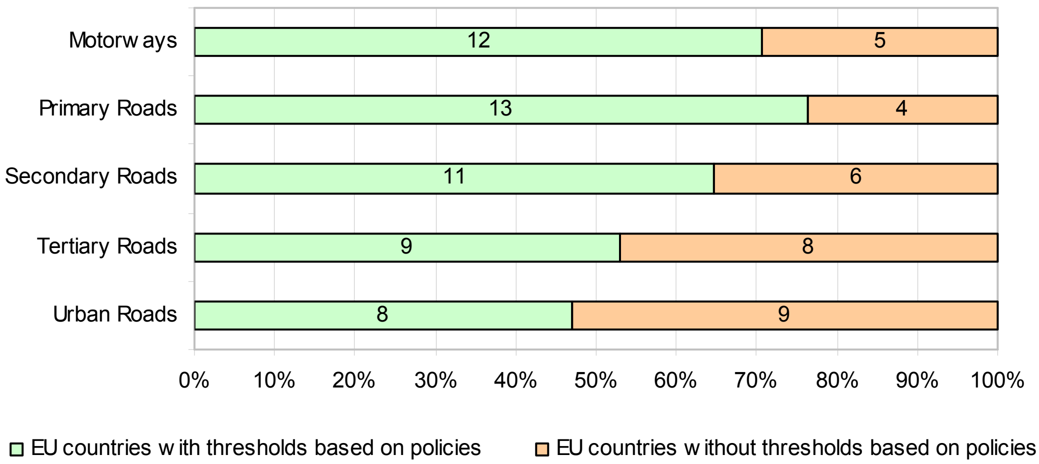


Figure 3-15: Proportions of EU countries with and without thresholds based on skid resistance policies, by network level

On motorways, the thresholds of 12 countries are based on the requirements of formal policies, regulations or standards. Slightly less than 50% of all countries have thresholds for based on policies applying to urban roads.

Although threshold levels may be applied as a result of a requirement of some form of policy, the actual values for the thresholds themselves can be derived in a number of ways. A common approach to setting thresholds is to look at the network from a statistical point of view; for example, by taking the cumulative frequencies of skid resistance values and drawing the limits at certain percentages. A more sophisticated (and scientifically correct) approach is to base thresholds on an analysis of accident risk, where the skid resistance level required is related to the actual accident risk for a particular section of road. It is also possible to set thresholds based on theoretical calculations (considering, for example, braking distances in certain circumstances or speeds on curves) or to use design parameters such as sighting distance or curve design speed as a basis. A further, somewhat simplistic approach, would be to copy or adapt practice in another country or on another network in the same country.

Figure 3-16 summarises the approach to threshold setting taken by the countries in the survey on motorways and primary road networks, to which the greatest proportion of policies apply. For motorways, the statistical method was the first approach in seven countries with analysis of accident risk being used in six. When thresholds are applied to lower network levels, the questionnaire responses suggested that they are typically adapted from the higher network levels.

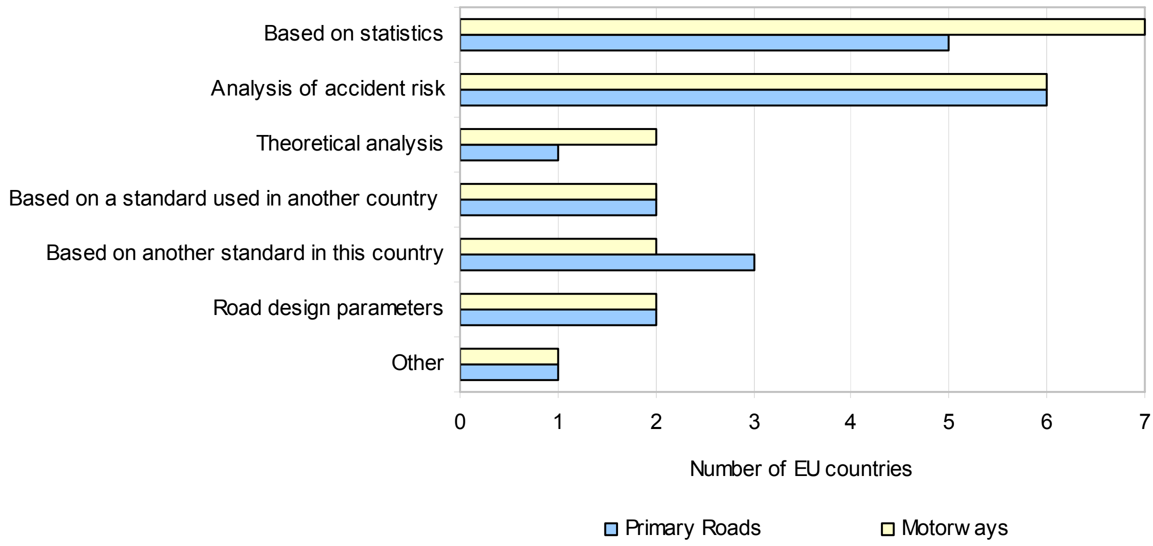


Figure 3-16: Number of EU countries according to how the skid resistance thresholds have been determined for motorways and primary roads

What are the thresholds for routine monitoring?

In each country that routinely monitors the road network, thresholds are used to classify the friction level of the roads measured. In the questionnaire, respondents were asked to provide an indication of the different thresholds used for each level of network. In making an overall analysis of the various responses, three main areas of potential difference between countries should be mentioned:

1. The basis of the threshold values.
2. The number of threshold levels and/or classes used
3. The actual threshold values.

It was found that the thresholds were based on different indices or coefficients that varied with measurement device. In countries where SCRIM is used to monitor the road network, the sideway force coefficient (or a value derived from it) is used to classify skid resistance. Countries applying the longitudinal friction measurement principle for routine monitoring use refer to the friction coefficient. Some countries also refer to SRT (Pendulum) values for their thresholds.

The number of thresholds varies from one (that is, a minimum required level) to five or more levels[4]. The number of levels depends on the network level, as well as on how detailed the country's policy is in terms of classifying road friction. If raw values are used, they depend heavily on the device used for the measurements.

[4] Five thresholds lead to six classes (e.g. very poor, poor, acceptable, average, good, very good).

Due to the differences identified above it is not useful to compare the values themselves. They can vary widely depending on the time of year at which measurements are made, weather conditions, road type or the certain part of the road being measured. In Sweden, for example, a single friction coefficient of 0.5 defines the only threshold that applies in summer, whereas in winter, the friction value should be more than 0.25, 0.30 or 0.35, depending on weather and road type.

3.2.7 Acceptance tests

On newly built roads, there is an expectation that skid resistance will be adequate and many countries have introduced limits for new roads that have to be demonstrated before the new road surface is accepted by the highway authority. The questionnaire explored this aspect of skid resistance measurements.

How many countries make acceptance tests?

The numbers of countries where acceptance tests are required for newly built roads are shown in Figure 3-17.

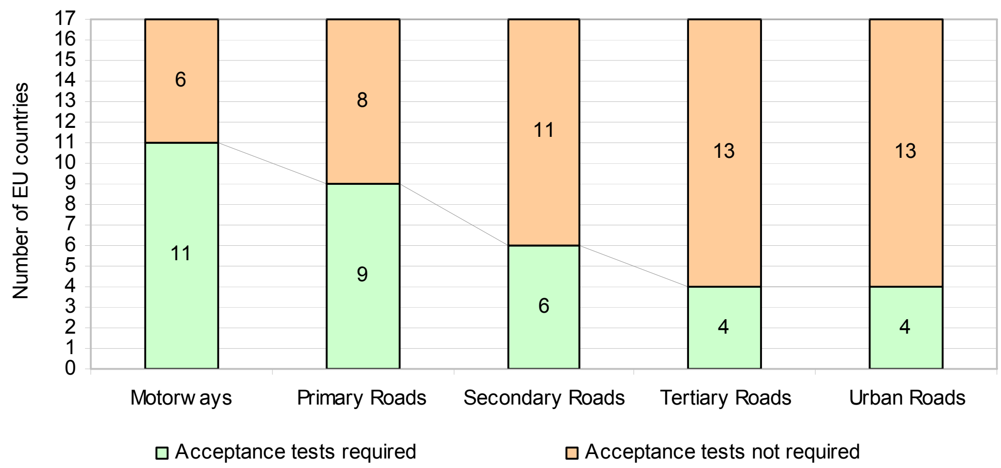


Figure 3-17: Proportions of EU countries with and without acceptance test requirements for skid resistance on newly built roads, by network level

A decrease through the network levels can be observed. As with routine monitoring, the network levels with the greater traffic importance have the longest tradition in acceptance testing. Generally, the lower the network level, more parties are responsible for maintenance. This may also be a reason why acceptance test are easier to establish on the higher level networks.

In almost all countries there is at least one policy, regulation or standard covering acceptance tests. The questionnaire asked respondents name these: they are listed in Annex II.

When are the acceptance tests carried out?

Acceptance tests for newly built roads may be carried out before opening to traffic but in some circumstances or for particular types of measurement, the tests may be made after opening. Figure 3-18 shows the proportions of EU countries carrying out acceptance test measurements in these different phases.

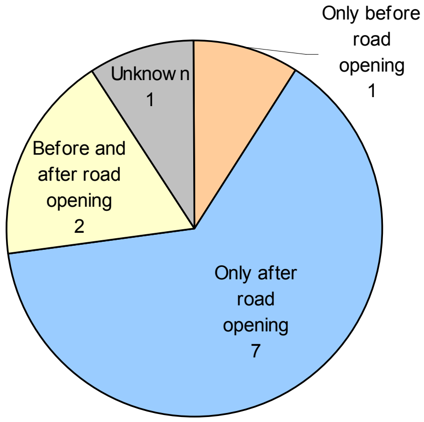


Figure 3-18: Proportion of EU countries carrying out acceptance tests for skid resistance before and/or after opening to traffic.

The majority of countries in the survey carry out acceptance tests after road opening. A possible reason for this could a time constraint: mandatory acceptance testing mostly applies to high level networks, where there is often high pressure to open or re-open roads quickly. This means that there may not be enough time to coordinate and carry out the acceptance test in the short period completing the surface and opening of the road.

In most countries, there is a short period after opening (usually several weeks), in which the tests have to be completed. Some countries set speed limits or warning signs s until the appropriate level of skid resistance has been verified.

What happens if the acceptance test fails?

Certain values have to be achieved in the acceptance tests. As explained in Section 3.2.6, these values can vary markedly from country to country and the factors on which the values depend also differ.

However, it is easier to compare the nature of the measures that are taken, either by the road authority or by the contractor, when the values measured in the acceptance tests are below the requirement. Figure 3-19 shows the numbers of countries taking various measures when an acceptance test is failed. In most countries, skid resistance improvement measures are required. Additionally, warning signs are placed. In four countries speed limits are imposed until sufficient skid resistance is proven. Five EU countries deduct money if there is only small shortfall. If there is a large gap between actual and required skid resistance, road construction may be necessary. Other measures can be a second measurement, for instance, to check whether skid resistance has improved after the initial bitumen film has worn.

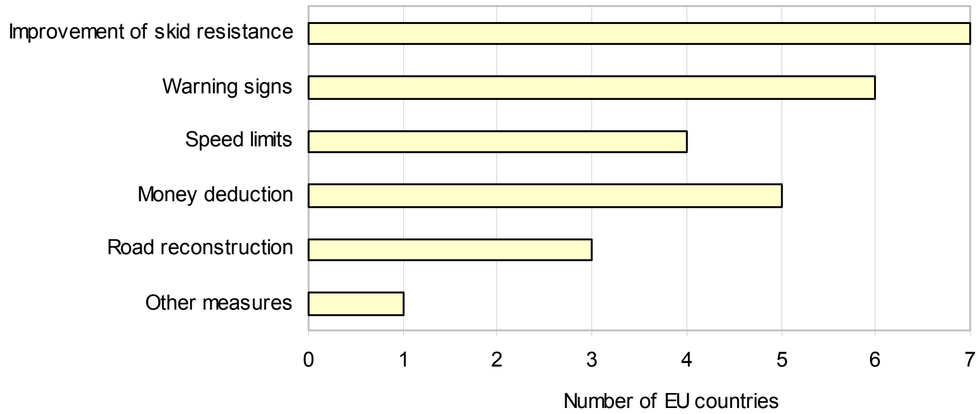


Figure 3-19: Number of EU countries taking various measures when an acceptance test for skid resistance is failed

In almost all countries, one measurement per acceptance test is considered sufficient. Only in Germany carries out two measurements.

3.2.8 Warranty tests

A successful acceptance test is often the beginning of a warranty period lasting between three and seven years. Figure 3-20 shows the numbers of countries that require warranty tests to check the skid resistance for different network levels.

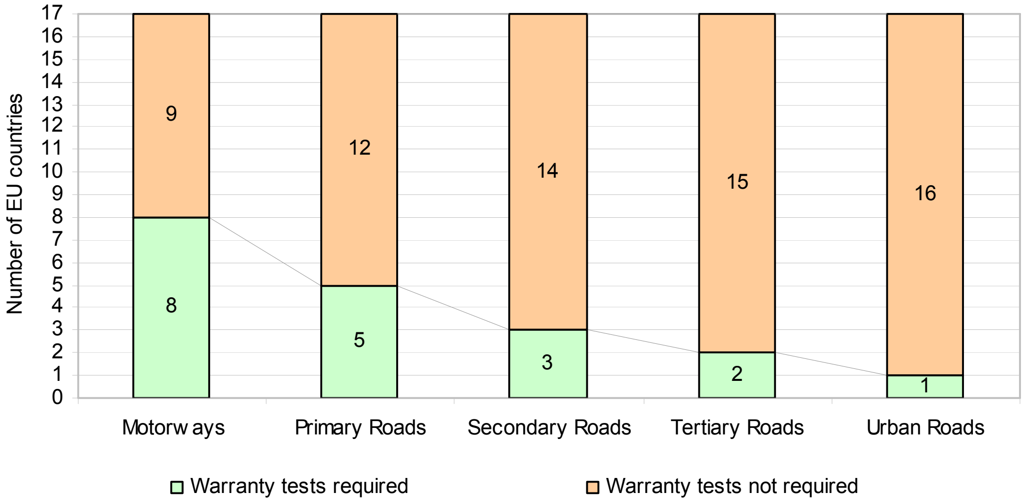


Figure 3-20: Proportions of EU countries with and without requirements for warranty tests for skid resistance, by network level

In comparison with Figure 3-17 (the proportions requiring acceptance tests), the numbers in Figure 3-18 are generally lower. The same pattern of a decrease through the network levels can be observed. This may be somewhat surprising, given that warranty periods are common in other fields and it is usual to couple acceptance tests with warranty periods or warranty tests. A possible reason for the lower use of warranty tests is that routine monitoring is carried out anyway. An advantage of warranty periods, of course, is that the costs for skid resistance improvement can be imposed on the contractor. However, conversely, it might be argued that contractors will increase prices to cover the increased risk associated with a warranty.

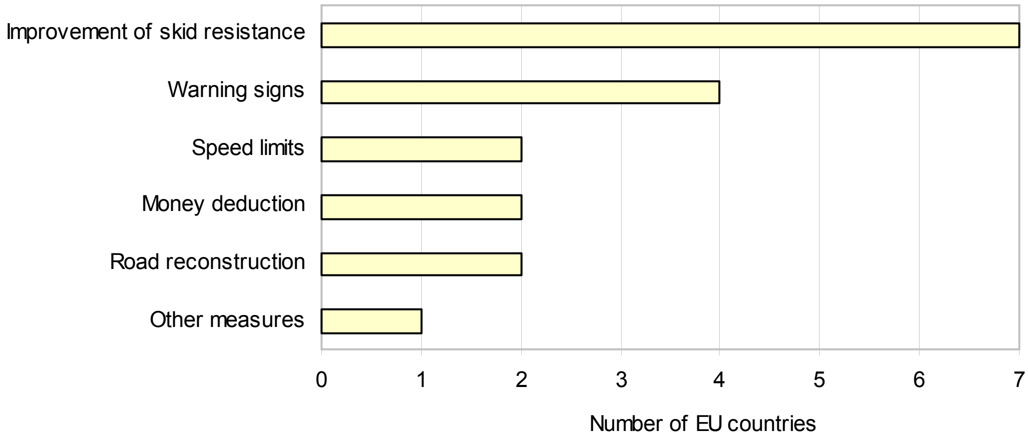


Figure 3-21: Number of EU countries according to measures taken in case of a failed warranty test for skid resistance

The obvious measure if defects are observed is to improve skid resistance (by some mechanical retexturing treatment). As with acceptance tests, warning signs are set up (in four countries in this case) and speed limits are imposed (in two countries). Money deductions and reconstruction of the road are measures taken in two countries if a warranty test fails.

3.3 Summary

Within the European Union, there are several approaches to the provision of appropriate skid resistance on roads. Different policies, standards and regulations have been investigated by sending out questionnaires and undertaking literature research. The analysis of policies for skid resistance has included information from 17 EU countries concerning policy management, measurement methods and devices, road network monitoring and standardized thresholds. Furthermore, practice of acceptance and warranty tests for newly built roads has been reviewed.

The European Union has not yet implemented a harmonized policy regarding skid resistance. The information collected has shown that there is marked variation in practice throughout Europe in relation to skid resistance policy, although some common ground has been identified. Four European of the countries included in the analysis do not have any policy at all regarding skid resistance. The others have a policy for at least one specific road category or network level. However, these tend to be for the high-level networks such as motorways and primary roads and on the low-level road networks in particular, the number of EU countries having a policy decreases noticeably.

The policies are mainly set by road authorities, though the road operator or national research institutes are involved in some countries. For motorways and primary roads, the majority of EU countries have introduced policies or standards which are legally enforceable.

In total, 15 different skid resistance measurement devices were been listed in the questionnaires as being used in European countries. The pendulum (SRT) is mentioned in most policies as a device for localised measurements. It is mainly used as a complement to mobile skid resistance measurement devices and is used for local investigations or as a research tool. One of the two similar devices operating on the transverse friction principle, SCRIM or SKM (Seitenkraftmessverfahren), is used in nine EU countries. The GripTester is the next most commonly used device, with eight countries using it. Generally, the longitudinal measurement principle is more commonly used, however (used by 12 EU countries). However, some countries use a number of devices based on different operating principles for different purposes.

Skid resistance measurements may be initiated as part of a programme of routine monitoring buy individual road crashes, or accident cluster analysis can also trigger measurements. Fourteen of seventeen EU countries routinely monitor their motorway and primary road networks but the number doing routine monitoring relating to skid resistance policies decreases noticeably towards the low-level networks. The monitoring frequencies vary from twice a year to every fifth year. Mostly, the measurements for routine monitoring are made between spring and autumn. However, in some northern countries routine monitoring is done in winter, even on icy roads.

Skid resistance of roads can be classified by defining threshold levels. These levels are based on different indices or coefficients describing the measured skid resistance. Standardised thresholds are commonly defined for high-level road networks but the analysis revealed many differences in the number of threshold levels, the values and the dependencies on measurement speed, weather and road type.

Many countries carry out acceptance tests to verify that newly built roads have adequate skid resistance. These measurements are mainly made a few weeks after road opening. If the acceptance test fails, most EU countries take measures to improve the skid resistance. Additionally, placing warning signs, deducting money and imposing speed limits are common measures taken.

While warranty periods are very common in other fields, this issue does not have a high importance in skid resistance policies. Less than fifty percent of all EU countries require have warranty tests, possibly because routine monitoring is carried out anyway.

The results of the analysis of policies regarding skid resistance provide a basis for the next stage of WP1 of the TYROSAFE project, which is to develop recommendations for harmonisation in the European Union. To achieve a harmonized policy, differences will need to be compared in more detail and the advantages and disadvantages of different approaches must be considered.

4 Rolling resistance

Rolling resistance (together with tyre/road noise), is one of the topics related to environmental aspects of the tyre/pavement interaction. It is directly linked to fuel consumption and therefore with the CO_2-emission of a vehicle driving on a road surface. The debate about the reduction of greenhouse gases is leading to efforts by industry and regulators to make improvements. On the one hand, the tyre-industry is developing new tyres that are safe and quieter but that will also have reduced rolling resistance. On the other, new tyre-related regulations and measurement standards are under development to introduce tyre labelling for reduced rolling noise and rolling resistance.

In order to reduce the fuel consumption of a vehicle by reducing the rolling resistance, two different measures can be applied. Either the rolling resistance of the tyres themselves can be reduced or the properties of the road pavement could be changed a way to reduce the vehicle's rolling resistance while driving on the road surface. The aim of the TYROSAFE project is not the improvement of tyres but the harmonisation of measurement standards of road surface properties. One of these properties is the rolling resistance of tyres on road pavements.

This chapter of the report deals with policies and measurement methods concerning the rolling resistance of tyres on different pavements. The main focus is on the characteristics of road surfaces that have the greatest influence on tyre rolling resistance. To gather information a literature review has been carried out a questionnaire has been sent out to several road institutes and road authorities.

In this chapter, findings from the most important literature reviewed will be presented. The literature review dealt with the interaction of road pavement properties, i.e. texture wave lengths, with rolling resistance or vehicle fuel consumption. The literature studied only describes the impact on passenger car tyres; no literature concerning the rolling resistance on road pavements in combination with commercial tyres could be found.

The literature review and the questionnaires indicate that there are no policies or standardised measurement methods related to tyre rolling resistance on different road pavements in use anywhere in Europe at present. However, one important regulation related to the examination of the rolling resistance of tyres is contained in ISO 18164; a short overview of this is included in Section 4.3 of this report.

4.1 Influences on energy consumption

Rolling resistance is a physical phenomenon that results in energy loss while moving a wheel or tyre over a surface. Hans Bendtsen from the Danish Road Institute (DRI) [5] identifies three main mechanisms through which the energy is lost:

1. Losses due to the bending/deformation of the tyre sidewalls
2. Losses due to micro-deformation of the tyre tread in the contact area
3. Losses due to slippage friction in the contact area between the tyre and the surface

In addition to these mechanisms, the inflation pressure, tyre rubber compound, tread pattern and the road surface texture could influence rolling resistance.

Vibrations due to the unevenness of the road the influence of the road's megatexture on the vehicle will result in some energy being absorbed in the vehicle suspension system (by heating the dampers). This is not a part of rolling resistance as it is defined above but another mechanism for the dissipation of energy that results from changing road properties.

Some of the test devices that have been used to examine the rolling of tyres on different road surfaces are included in the next section.

Part of the SILVIA project was a literature review that dealt with the interaction of the rolling resistance with fuel consumption. The focus of that investigation was a cost/benefit analysis of low noise road pavements [5].

The conclusions from that literature review are as follows:

1. The fuel consumption of a vehicle is directly influenced by the rolling resistance.
2. Road surfaces can be responsible for roughly doubling the rolling resistance of a vehicle's tyres and therefore roughly increasing the vehicle's fuel consumption about 10%.
3. Where there is an uneven driving pattern (frequent changes from acceleration to deceleration, for example, in urban traffic), improvement of a pavement's rolling resistance affects fuel consumption only marginally.
4. Unevenness and megatexture of pavements seem to be the most important properties of a road surface in influencing the rolling resistance.

4.1.1 Macro- and megatexture

The Swedish National Road and Transport Research Institute (VTI) conducted an experiment with a passenger car that was equipped with a special device to measure the fuel consumption of the car. It was driven over 20 different road surfaces on public roads. As well as the fuel consumption, the road pavement properties, i.e. the texture, was measured using a mobile laser. The report states that the texture measurement device was not able to measure texture wavelengths shorter than 2 mm. The measured wavelength range was between 2 and 3500 mm. The test tracks were driven in both directions to minimize the influences by wind (speed and direction) and gradients [9].

The report says that the texture (and especially the wavelengths of the spectrum) had an influence up to 11% on the fuel consumption of the test-vehicle. The best correlation between fuel consumption and texture wavelength was found in the spectrum of shortwave unevenness (in this context, wavelengths between 0.63 m and 3.5 m). Microtexture, which was not measured but estimated during this test series, was considered to have no influence on the vehicle's fuel consumption (the report does not mentioned how microtexture was estimated). The correlation between fuel consumption and macrotexture was significant (0.6) but not so strong as it was for megatexture (0.83) and unevenness (0.91) [9].

The following conclusions were drawn from the analysis:

1. A clear correlation between fuel consumption and macrotexture and a very good correlation between fuel consumption and shortwave unevenness was found.
2. An uneven road may increase the fuel consumption by up to 12% relative to an even road.
3. A rough macrotexture may increase fuel consumption by 7% relative to a very smooth macrotexture.

4.1.2 Macrotexture and evenness

Another research study [8] focussed on the influence of macrotexture and unevenness of road pavements on vehicle fuel consumption. To estimate this, three tests were conducted. A laboratory measurement with a vibration bench was used to simulate road unevenness; measurements were made on a test track to compare different road surfaces and an analysis was made of direct fuel consumption measurements on a sample of public roads in France.

The tests on the vibration test bench were carried out in order to investigate the energy loss in the dampers of a vehicle. Different wave-lengths were tested, namely:

- short wavelengths ranging from 1 to 3.3 m
- medium wavelengths ranging from 3.3 to 13 m
- long wavelengths ranging from 13 to 40 m

The test track near Nantes was chosen for its extremes of macrotexture combined with even surfaces. The SMTD values ranged from 0.1 to 3 mm.

The tests measurements of fuel consumption of a vehicle driving on actual roads were made on different public roads in France. However, it is not clear how the influences of air drag and other environmental factors were taken into account in the study [8].

The study arrived at the following conclusions:

1. Tests on the vibration test bench showed that long wave-lengths had no impact on fuel consumption since the vehicle was not running. In reality, these long wave-lengths may have an impact on the trim of the vehicle leading to in increased fuel consumption due to increased air drag.
2. The tests on the track near Nantes showed that the smoother the surface was, the smaller was the proportion of fuel consumption attributable to rolling resistance.
3. Increased fuel consumption was measured in the range of 0 to 0.4 l per 100 km due to the influence of unevenness and 0 to 0.4 l per 100 km due to the influence of a change of macrotexture “from fine to exceptionally coarse” (SMTD values from 0.4 to 1.2 mm).

4.1.3 Pavements

This section is a summary of a literature survey that dealt with the question of whether asphalt roads are more or less environmentally friendly than concrete roads. It is not the purpose of this report to answer that question, but the findings from the literature survey are of interest. The review states that the road surface has a big influence on the fuel consumption of a vehicle and therefore on its CO_2-emissions. Four factors are mentioned as influencing the rolling resistance of a tyre rolling on a road surface [4]:

1. Energy loss as a result of the friction between the tyre and the pavement.
2. Energy loss as a result of the deformation of the tyre itself.
3. Energy loss due to the energy dissipation in the shock absorbers, caused by road unevenness.
4. Energy loss caused by the viscoelasticity of the road pavement.

As a result of this investigation the author states that some surface properties (macro- and megatexture, unevenness) have an important influence on rolling resistance. The influence of microtexture is not mentioned in this report. It is claimed that a reduction of fuel consumption is associated with the reduction of aggregate particle sizes and spacing. It is also noted that under wet weather conditions a higher macrotexture can influence the rolling resistance positively because of the ability of reducing the depth of the water-film and as a result of this a decreased amount of energy to remove the water in the contact area between tyre and surface.

4.2 Current practices for measuring rolling resistance

4.2.1 Gathering information

A questionnaire was sent out to selected European road research institutes and road authorities in order to find out what measurements have been performed or are being undertaken at the moment to investigate the rolling resistance of tyres on road pavements. A further aim of this questionnaire was to find out whether there were any national regulations for investigating the rolling resistance of tyres on road pavements.

In detail, the questionnaire consisted of six questions, addressing:

- The existence of national policies or regulations concerning road pavements' rolling resistance.
- The awareness of government or road authorities to the potential of saving fuel and consequent reduction of CO_2-emissions by reducing rolling resistance of road surfaces.
- Any opinion as to whether there is a benefit in reducing the rolling resistance of road pavements.
- The existence of ongoing or planned measurements of the rolling resistance of road pavements.
- The availability of equipment to measure rolling resistance.
- The type of measurement procedure(s) or regulation(s) used.

Thirteen questionnaires were sent out and twelve completed responses were received. All the respondents indicated that they had no national regulations or policy relating to rolling resistance thresholds of road pavements.

Half of the questionnaires analysed indicated that the government of the country concerned was aware that there was a potential of saving in fuel and reduction CO_2-emissions by using rolling resistance optimized road pavements.

With the exception of one, all respondents replied positively to the question asking whether they thought that a benefit for the environment could be achieved by reducing the tyre rolling resistance on different pavements.

Half of the countries approached carry out tests related to the measurement of rolling resistance on the road pavements in their country, but the test equipment used differed from one country to another. Four institutes use a rolling resistance trailer and three have drum facilities currently in use. It is unknown so far whether or not rolling resistance measurements on the pavements studied have been combined with texture measurements. No further information was provided about the tyres used.

Generally, to measure differences in rolling resistance on different road pavements, a standardised tyre ought to be defined and used. However, no such tyre exists at present. By contrast, reference tyres are in common use with the determination of noise emission (although the process of defining such tyres has been difficult).

The measurement procedures are as diverse as the test equipment. Two institutes that own a rolling resistance trailer use a methodology for measuring rolling resistance that was developed from experimental data. These two institutes use identical trailers. The laboratories that are equipped with drum test facilities perform their rolling resistance tests according to ISO 18164. The third operator of a trailer follows this regulation. There was no information about the methodology of the tests that are conducted with the fourth trailer.

4.2.2 Measurement methods and devices

In principle three different methods are available in order to examine the rolling resistance of road pavements:

- Measurements using a drum (in some cases real surfaces can be applied)
- Measurements using a special trailer on real surfaces.
- Measurements using vehicles, that are equipped with a device to measure the fuel consumption

In addition to these basic principles, a study at the Transport Research Laboratory in the UK has used a facility designed to assess the strength of road pavements to attempt to measure rolling resistance on truck tyres [17]. This large facility uses a loaded truck tyre that is moved repeatedly from side to side across specially constructed pavements. The one aspect of the study was to measure rolling resistance on pavements constructed with different strengths and textures. It is not analysed in detail here, but the techniques explored do offer the possibility of a future technology for measuring rolling resistance on different pavements.

The advantages of test made in a laboratory are that measurements should have better reproducibility and the characteristics of a test-bench allow boundary conditions to be adjusted in a controlled way. Test drums for tyre tests are available in two different basic designs: “external drums” on which the tyre rolls on the outer side of the drum and “internal drums” that enable the tyre to roll on the inner side of the drum.

Test facilities in which the tyre is rolling on the outer side of the drum are usually rather small. This has the advantage of relatively cheap testing equipment. The disadvantage is that real pavement surfaces cannot be used. Typically, the tyre rolls on sandpaper or other kinds of replica surfaces. Therefore, although they can be used to examine the rolling resistance of tyres, they are of limited use to assess different surfaces. An additional problem is that the curvature of the drum is opposite to that of the tyre, which forces the loaded tyre to bend in its contact area in the opposite way to its natural curve. As a result of this, additional energy will be lost in the tyre during the “unnatural” bending of the carcass and the sidewalls.

Internal drums tend to be large – they need a diameter of 4 m or more in order to provide a relatively flat surface on which the test tyre can roll so that the influence of the curvature can be treated as marginal. This inevitably leads to a high cost for the test equipment. However, a major advantage is that it is possible to fit cassettes filled with real pavement materials in these test facilities.

One such these large drum is the vehicle/pavement interaction test facility at BASt in Germany, illustrated in Figure 4-1.

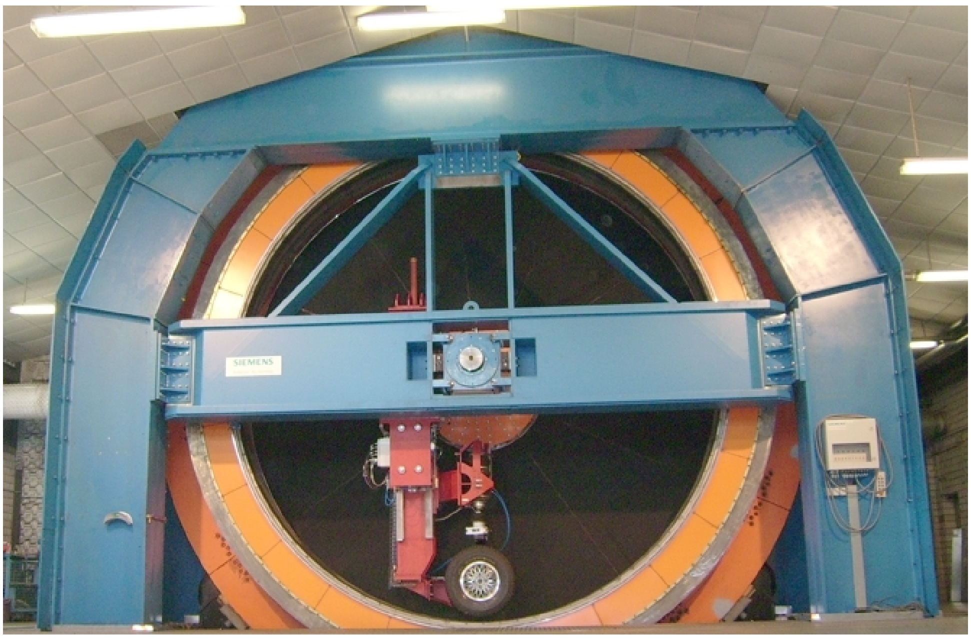


Figure 4-1: Vehicle/Pavement interaction test facility at BASt

This test facility consists of a drum with an inner diameter of 5.5 m into which cassettes filled with real pavement materials can be installed. The maximum width of the pavement cassettes is 90 cm. Three different wheel suspensions can be mounted: one special rolling resistance wheel suspension for passenger car tyres, one suspension for for acoustic measurements with passenger car tyres and a truck tyre suspension with the possibility of a twin tyre assembly. The maximum wheel load is 6.5 t. This test facility is suitable for rolling resistance measurements on both passenger car and truck tyres.

Special rolling resistance trailers use one or more axles and an additional wheel that is the testing wheel. Although it is possible to investigate the rolling resistance of any kind of road pavement with this kind of testing equipment, the influence of climate (temperature, humidity) and road gradient is present, as well as body vibrations, which all result in dynamic changes in the tyre/wheel-load. Some of these influences can be eliminated with certain corrections. A further disadvantage is that the measurements are made on public roads with the risk that some test runs may fail due to the influence of traffic.

Figure 4-2 shows the rolling resistance trailer developed at the Technical University of Gdansk (TUG). This trailer is also used by VTI for their rolling resistance measurements on road pavements.

Figure 4-2: Rolling resistance trailer of TU Gdansk, which is also used by VTI

Ejsmont *et al* [13] describe the principle of operation of the TUG-trailer. The device has three wheels. The two front wheels are self-steering in order to follow the towing vehicle and provide stabilisation and support for the trailer. The measuring wheel is mounted at the rear of the trailer. Figure 4-3 gives a closer view of the test wheel viewed from the right-hand side of the trailer.

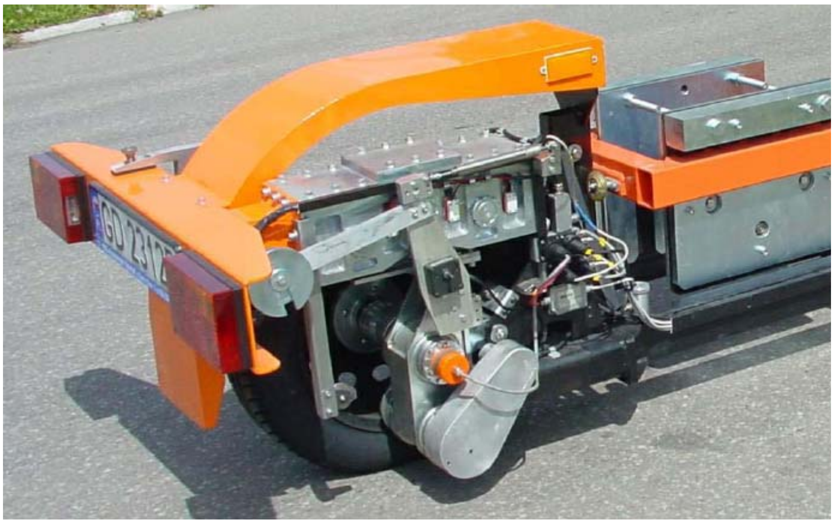


Figure 4-3: The measuring wheel of the TUG-trailer in detailed view

The principle of operation is illustrated in Figure 4-4. The test wheel axle is mounted on an arm that can rotate relative to the central beam in response to the rolling resistance force. The higher that force, the greater is the angle between the trailer's plane and the rotating arm.

Figure 4-4: Principle of operation of the TUG rolling resistance trailer [18]

The Belgian Road Research Institiute (BRRC) also owns a rolling resistance measurement trailer, although it is currently out of use while it undergoes restoration. Another trailer is operated by BASt in Germany. This is illustrated in Figure 4-5 and its operating principle is shown in Figure 4-6.

Figure 4-5: Rolling resistance trailer of BASt

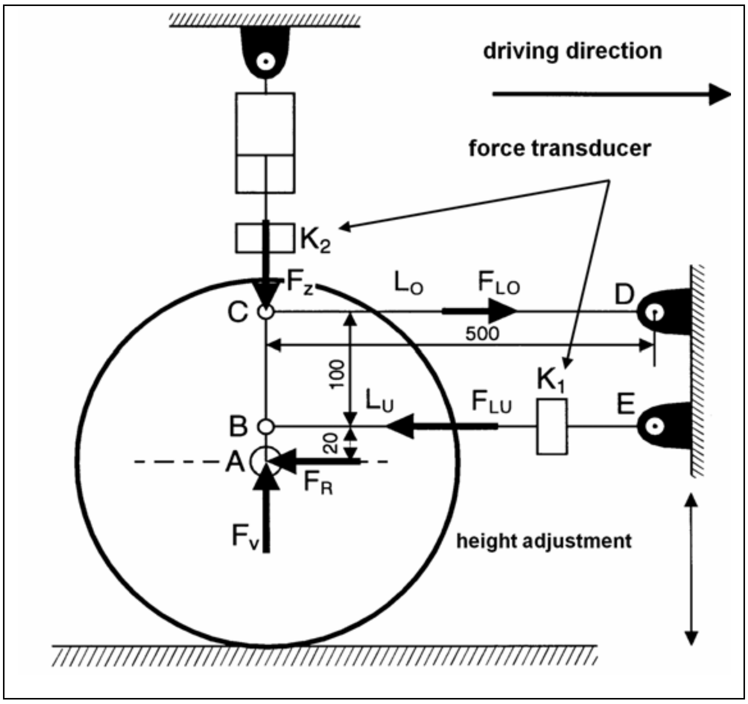


Figure 4-6: Operation principle of BASt's rolling resistance trailer

Two forces are measured, in the vertical (K2) and horizontal (K1) directions, after applying a force in the vertical direction as wheel load. The load cell in the horizontal direction (K1) measures directly the reaction force due to the rolling resistance of the tyre on the pavement it is rolling on.

The usage of specially-equipped vehicles allows rolling resistance to be measured indirectly by measuring fuel consumption or by using the coast-down method. All of these methods are influenced by air-drag, road gradient, wind speeds, temperature effects and friction in wheel bearings. It is found that measurement of fuel consumption turns out to be not very accurate, because not only do these factors affect rolling resistance in the tyres, they also contribute to energy loss in the power train. It is difficult to eliminate these influences.

4.2.3 Rolling resistance of tyres on road pavements

The main topic of a report by Roovers, de Graaff and van Moppes [19] is the comparison of measurement results from different rolling resistance trailer systems, including a comparison of measurements from outdoor and indoor tests. The indoor measurements took place using the BASt internal drum machine (see 4.2.2). The outdoor measurements were performed on various public roads and German and Dutch highways.

Roovers *et al* divide the pavement into classes according to their surface texture characteristics as follows:

- *Microtexture,* defined as wave lengths from 10^{-3} mm to 5 mm.
- *Macrotexture,* defined as wave lengths from 5 mm to 50 mm.
- *Megatexture,* defined as wave lengths from 50 mm to 500 mm.

A good correlation between microtexture and rolling resistance was detected in the drum tests, with a value of 0.97. In the outdoor measurements, the correlation of rolling resistance and microtexture decreased to a value of 0.71, due to the influences of road unevenness which results in body vibrations.

To sum up, the authors stated that the best correlation between rolling resistance and road properties in outdoor measurements can be found with the correlation of 0.75 between rolling resistance and macrotexture. Table 4-1 shows a comparison between the correlations of indoor and outdoor tests.

Table 4-1: Correlations of road characteristics and measurement environment

Characteristics compared	test facility (indoor)	trailer (outdoor)
microtexture ↔ rolling resistance	0.97	0.71
macrotexture ↔ rolling resistance	0.89	0.75
megatexture ↔ rolling resistance	0.74	0.67

The influences of shortwave unevenness, which are defined as wave lengths from 500 mm to 50 m, were not investigated during these tests.

4.2.4 Round Robin Test Rolling Resistance / Energy Consumption

In 2004 the Dutch Ministry of Traffic and Waterworks, DWW, assigned six parties to carry out a round-robin test for four different rolling resistance measurement devices. These were the TUG and BASt trailers and two instrumented vehicles, one diesel fuel vehicle and an electric car. Two tyres were used for the measurements with the trailers, one profiled and one smooth. The pavements tested were on public roads in the Netherlands and in Germany. Overall eight different pavement types were tested. Two were cement concrete but with different textures (one with smooth burlap and one transversely brushed). The remaining six pavements were made of asphalt, including two double layer porous asphalts with different chipping sizes (2/6 and 4/8) [18].

The tests took place in November 2004; Table 4-2 shows the different rolling resistance coefficients for the profiled tyre.

Table 4-2: Ranking of the investigated highway road pavements based on the average rolling resistance coefficient of the profiled tyre

Pavement type	cR_{25} [%]
Cement concrete with burlap – smooth	0.86
Stone mastic asphalt 0/8	0.86
Double layer porous asphalt 2/6	0.97
Double layer porous asphalt 4/8	1.02
Cement concrete transversely brushed – rough	1.04
Single layer porous asphalt 6/16	1.05
Dense asphalt concrete 0/16	1.09
Gussasphalt 0/11	1.18

The report on the exercise states that the spread of repeatability for the rolling resistance measurements for the trailers are between 4% and 7%.

4.3 ISO 18164

This Section of the report gives an overview of the regulation ISO 18164 that describes the methodology of the rolling resistance of tyres on special test surfaces. It is known that the ISO/DIS 28580 already exists as a draft version but until it reaches its final status, ISO 18164 continues to be used. There is also another draft European Regulation that will replace many former tyre regulations but the current version does not include any arrangement to deal with any thresholds for the rolling resistance of tyres. Since no agreement has been reached on what future thresholds might be, the process of incorporating provisions for tyre rolling resistance into this document has been prorogued.

ISO 18164 is designed for the use of a drum facility with the tyre running on the outer drum surface with artificial surfaces installed.

The purpose of ISO 18164 is to provide a specification for measurements of rolling resistance "under controlled laboratory conditions, for new pneumatic tyres designed primarily for use on passenger cars, trucks, buses and motorcycles" [16].

This standard makes arrangements of four different test methods, which the tester can choose individually:

- Force method: measurement of the reaction force at the tyre-spindle.
- Torque method: measurement of the torque input at the test drum.
- Power method: measurement of the power input to the test drum.

- Deceleration method: measurement of the deceleration of the test drum and the tyre assembly.

Apart from the first measurement method, the measured values also include bearing and aerodynamic losses of the wheel, the tyre and the drum. These losses are to be considered by calculations or measurements of the parasitic losses. For example for the deceleration method, some measurements have to be made before the rolling resistance test in order to estimate the following parasitic losses:

- Rotational moment of inertia of the test drum.
- Coast-down test in order to determine the air drag and bearing friction of the drum.
- Rotational moment of inertia of the tyre/wheel assembly.
- Coast-down test with tyre/wheel assembly to determine air drag and bearing friction.

Table 4-3 and Table 4-4 show briefly the boundary conditions of the tests according to ISO 18164.

Table 4-3: Test speeds for tyre rolling resistance tests according ISO 18164

Tyre type	Passenger car	Truck and bus			Motorcycle	
Load index	all	≤ LI 121	> LI 122		all	all
Speed symbol	all	all	F to J	K to M	≤ L	> L
Speed	80	80	60	80	50	80

Table 4-4: Test loads and inflation pressures for tyre rolling resistance tests according ISO 18164

Tyre type	Passenger car		Truck and bus	Motorcycle	
	Light and standard load	Reinforced or extra load		Standard load	Reinforced or extra load
Load % of maximum load capacity	80	80	85 (% of single load)	65	80
Inflation pressure [kPa]	210	250	Corresponding to maximum load capacity for single application	200	250

4.4 Summary

It is certain that road pavements influence the fuel consumption of a vehicle while it is being driven. However, it is not clear which of the different pavement surface characteristics (micro-, macro, megatexture and unevenness) has the greatest influence on rolling resistance. Neither is it certain whether or not the viscous elasticity properties of road pavements, especially asphalts, have an effect on the rolling resistance. This might become evident at higher wheel loads, so investigations should made to find whether this affects the fuel consumption of commercial vehicles only or passenger cars as well.

Currently there are no policies or standardized measurement methods anywhere in Europe concerning the tyre rolling resistance on different road pavements. Various measurement methods and types of measuring equipment are used but they are so different from one another that it is difficult to compare the results. Small drums with the tyre running on the outer drum-surface are not suitable for investigating the influences of road pavement properties on rolling resistance. In order to investigate the rolling resistance of tyres on different pavements, round-robin tests should be performed as well as tests at large internal drum test facilities where cassettes with real pavement surfaces can be installed.

5 Noise emissions

Recent estimations indicate that more than 30% of EU citizens are exposed to road traffic noise levels above acceptable limits as viewed by the World Health Organisation (WHO) and that about 10% of the population report severe sleep disturbance because of transport noise at night. The noise emission around major road infrastructures is being evaluated and action plans will be proposed through the application of the European Directive 2002/49/CE [21]. Because tyre-road noise is the dominant source for vehicles above relatively low speed (around 30 km/h for passenger cars and 50 km/h for trucks), road surface characteristics play a major part in road noise generation. Low noise road surfaces significantly and beneficially reduce road traffic noise in addition to other abatement measures, such as tyre or vehicle noise limitation, speed reduction and noise barriers.

However, it seems that further development of low noise road surfaces at the European level is limited by the lack of common procedures for the qualification and the assessment of noise properties of road surfaces. If acoustic measurement methods and classification systems already exist in some countries in Europe, they are neither harmonised nor comparable. A significant effort has been made during the past ten years to develop standardised methods for road noise measurements, but this still needs to be continued.

In this Chapter of the report, current and prospective methods for the evaluation of road noise emission for the noise classification and assessment of road surfaces are reviewed. Detail is given on the existing tools, the European context and the existing standards for measurement methods. Then the current policies regarding low noise surfaces and the assessment of noise properties of pavements will be examined, partly relying on a survey that was conducted during the project.

5.1 Current practices for road noise reduction

Environmental noise annoyance is a complex issue that involves not only physical but also psychological and sociological phenomena. In the process, the three following steps can be distinguished: sound emission, propagation and perception. Perception is an extremely complex topic due to the many individual, social, environmental and cultural parameters. Although it is a crucial step in the annoyance process, actions aimed at reducing perception are rare, if they exist. The principal activities are the various communication actions such as information campaigns or public meetings that Road Authorities organise for residents. They are usually held in the context of Environmental Impact Assessment in the case of new road projects, but can also be organised for existing roads. These communication actions can have a positive effect on the noise perception of residents.

In practice, road noise mitigation is mainly achieved by reducing or limiting sound emission and sound propagation. Existing techniques can be distinguished depending on whether they affect the sound source emission or the propagation of the sound once it has been emitted. Source orientated actions are often preferred because their effect is wider and not limited to restricted areas. They are also often claimed to be more cost-effective. Actions on noise propagation are in general easy to apply and can rapidly bring a significant noise reduction, but only in a limited area. However, in general, there is no unique, ideal solution for reducing noise but the choices must be made that depend on objectives, technical constraints, cost and the residents' wishes. A combination of several noise reducing techniques is often used for dramatic cases.

Source orientated actions

Noise emission of road vehicles is attributed to three main sources: propulsion noise (including engine, power train, exhaust and intake systems), tyre-road interaction noise and the aerodynamic noise. Engine noise is the dominant source at low speed, i.e. below 30 km/h for passenger cars and 50 km/h for trucks, especially in the acceleration phase. Above this speed, tyre-road noise becomes the dominant source for vehicles [22]. Aerodynamic noise increases with speed but it is assumed to be dominated by tyre-road noise at least at speeds below 130 km/h. In this context, it is obvious that tyre-road noise is the principal mechanism of noise generation to be mitigated in many urban conditions and in most suburban and extra-urban situations.

- The first action to reduce road traffic noise emission was the introduction in 1970 of regulations on vehicle noise emission and later on tyre noise emission. Thus, Directive 70/157/EEC and subsequent amendments [23] defines the noise test for the type approval of new vehicles and sets noise emission limits. Directive 2001/43/EC [24] complements the vehicle noise standards by setting a test procedure and noise limit values for tyre rolling noise. According to the Green Paper [25] on future noise policy from the Commission of the European Communities (1996), noise from individual cars and trucks has been reduced by 85% and 90%, respectively, since 1970. However, despite more than thirty years of source reduction policy by means of type approval, the emission of traffic noise has not decreased. The growth of traffic has surpassed the rather small technological improvements regarding noise emission from traffic on national roads. As a result, there has been no reduction in community exposure to road traffic noise [25].
- Tyre-road noise can be limited by the use of low noise road surfaces. Research efforts made during the past decades both by public research institutes and by the road industry has led to the availability of several low-noise road surfaces: porous asphalt courses in single or double layers, bituminous thin layers with small chipping size and possibly some open porosity, porous cement concrete, stone mastic asphalt thin layers, rubber asphalt pavements. Large data bases of noise performances of road surfaces have been built that can help road authorities to anticipate the noise reduction to be expected as a result of changing the road surfacing. They also show that the important parameters of the road surface guaranteeing a reduced noise emission are a relatively smooth macrotexture, usually obtained by a small maximum aggregate size (6 to 10 mm but 4 mm has been recently achieved), and a significant void content producing some open porosity of the rolling course. The main concern when using road surface as a noise reduction technique is that the ageing effect is not yet sufficiently understood to be taken into account. Low-noise road surfaces usually lose their initial properties, more or less rapidly, as a result of the effects traffic

(wear, stripping, pavement distresses…) and physical and chemical ageing processes (stiffening, clogging…). This can be accelerated in urban areas due to the frequent works of various suppliers (gas, water, sewage…etc).

- Finally, alternative measures can be used to reduce noise emission at the source, related to traffic management. Among them, the most common is the limiting of traffic speed, which is significantly effective provided that smooth traffic flow is preserved. For instance, examples have been shown of the beneficial effect on noise exposure of chicanes, traffic calming devices, speed limits and after the transformation of a traditional crossing into a roundabout.

Actions on noise propagation

- The most common tool for road traffic noise reduction is the construction of noise barriers. The principle is to erect an earth berm or a wall between the source (the road) and the receiver (exposed building) to prevent sound from propagating. The sound wave is not totally stopped due to possible sound transmission through the structure and what is essentially a diffraction effect on the top and on the edge of the obstacle. An acoustical “shadow zone” is created behind the barrier where noise levels are substantially lowered. Effective noise barriers can reduce noise levels by as much as 12 dB(A) but only at specific locations. A barrier becomes less efficient at longer distances behind it, at higher levels and at locations close to the edges. The main parameter defining the efficiency of the barrier is the size (height and length). The material is in principle sufficiently dense to provide enough sound insulation so that sound transmission is negligible compared to diffraction. The material facing the traffic can be sound absorbent in order to avoid sound reflections on the opposite side of the road.
- When noise source protection measures or barrier construction are impossible or not sufficient, the ultimate solution for noise abatement is the improvement of façade insulation of exposed buildings. This usually consists in improving glazing, windows, and air inlets of exposed façades. This solution is often used when other solutions are not technically possible, or would be too expensive (for instance, when only a few buildings are to be protected), or in the case of several noise sources at different locations (several roads, railway, factory…). This solution is relatively easy to implement. The disadvantage is that only inner areas are protected and the efficiency is nullified when windows are open.
- Actions on urban planning must also be cited among the protections measures against road noise, although the opportunities where application is possible are rare. But in situations were acousticians are involved sufficiently early in the urban planning project, several “tricks” can be applied to avoid unnecessary exposure of façades to road noise. For instance, offices and other activity buildings can be placed close to the road so that they shelter the residential buildings; new buildings can be oriented in such a way that a minimal surface of façade is exposed to the road noise.

5.2 Current policies and standards in the EU

Noise maps and action plans

The Directive on Environmental Noise 2002/49/CE [21] was aimed at requiring competent authorities in Member States to produce strategic noise maps of noise emitted in the vicinity of large infrastructures of transport (road and rail), and in large cities on the basis of harmonised indicators. It also aimed at informing the public about noise exposure and its effects, and at drawing up action plans to address noise issues.

Noise maps permit the global evaluation of noise exposure and forecast the evolution of noise levels. They will be used to assess the number of people annoyed and sleep-disturbed respectively throughout Europe. Action plans for noise reduction will list the measures to be taken for noise reduction in critical situations identified on the maps. The directive does not set any limit value, nor does it prescribe the measures to be used in the action plans, which remain at the discretion of the competent authorities.

Thus, noise maps have to be drawn for all large road infrastructures bearing more than 6 Mio. vehicles per year (i.e. approximately 16.000 vehicles per day on average). The mapping includes:

- graphical documents:
  - a graphical representation of equal noise areas per 5 dB(A) step, starting from L_{den} > 55 dB(A) and L_n > 50 dB(A), together with the source localisation
  - the areas in which noise levels exceed the limits
  - the evolutions that can be anticipated
- numerical data:
  - the estimation of the number of buildings identified in critical zones, the number of corresponding people
  - the surfaces of exposed areas

Noise levels are calculated at distances up to 500 - 600 m from the road infrastructure. For each building, noise levels at the most exposed façade are evaluated. When the situation is simple (e.g. a straight road in a flat environment), simplified calculation schemes are often used. However, more sophisticated simulation software must be used in more complex situations, especially in dense urban areas.

Tyre and vehicle regulation

- The first action to reduce road traffic noise emission was the introduction by the European Community of regulations on vehicle noise emission in 1970 by means of type approval. Vehicle noise standards are laid down in Directive 70/157/EEC and subsequent amendments [23], which regulates the technical approval of new vehicles and currently sets noise emission limits of 74 dB(A) for passenger cars and 80 dB(A) for trucks. The noise limits include all sources of noise from the vehicle. While type-approval noise limits have been gradually tightened over the years (by a reduction of more than 10 dB(A) for certain vehicles), no improvement has been made regarding overall exposure to road traffic noise, due largely to a significant increase in road traffic and a trend towards larger, heavier and more powerful vehicles. Furthermore, it has been recognised that the test cycle for vehicle certification on noise levels is not representative of normal driving conditions, especially for typical urban stop-start situations at lower speeds, where engine noise is dominant. As a consequence, the test cycle is currently under review [26]

- Regarding tyre, Directive 2001/43/EC [24] complements the vehicle noise standards by setting a test procedure and noise limit values for tyre rolling noise. The directive states that the limit values should be reviewed and revised after 36 months. Thus, a report making recommendations for the revision of the limit values and other aspects of the directive was presented to the European Commission in 2006 [27]. The report shows that approximately half of the tyres are over 3 dB(A) quieter than the current limits, and some of them are as much as 8 dB(A) below the limit. The reports suggest in its conclusions stricter limit values for passenger cars and truck tyres. It also demonstrates that quieter tyres do not compromise safety (wet grip, aquaplaning) or fuel economy (rolling resistance), and that the proposed limit values for tyres for cars and trucks would lead to an estimated overall noise reduction of up to 3 dB(A). At the time of writing, no formal proposal of revision has come out from the EC.

Road surface regulation

To date, there is no European regulation regarding the use of low noise road pavements. Some Member States have developed a policy to promote the use of low noise pavements. A need for a common system of assessment of low noise pavements has been expressed on several occasions by different bodies.

During the summer of 2006, EC DG ENV commissioned COWI and BRRC to organise a stakeholder workshop to investigate the opportunities and feasibility of a possible acoustic classification system for road pavements [28]. The main conclusion is that low noise road surfaces can significantly and beneficially reduce road traffic noise in addition to noise limitation of vehicles and tyres or other abatement measures. Furthermore, road surfacing should be locally considered under noise action plans arising from by Directive 2002/49/EC. It was pointed out that many acoustic measurement methods and classification systems already exist in Europe, but they are neither harmonised nor comparable. Moreover, some systems refer to commercial products and are not technologically neutral – or they introduce restrictions onto the access to national markets for low noise road surfaces. The workshop concluded that there is a need in Europe for harmonised standards if one wants to foster healthy competition. ISO and CEN standards already exist, which may support the elaboration of the CEN standards needed and be beneficial for public procurement authorities.

In parallel, the EU coordination action INQUEST (Information Network on QUiet European road Surface Technology) was also commissioned under the Sixth Framework Programme of the EC. The aim was to foster the use of low-noise pavements throughout Europe by disseminating the knowledge and experience. In particular, the group was asked to set up a

European "user group" of the main stakeholders, with a view to paving the way to future European standards on the classification, labelling and conformity of production testing of low-noise road surfaces. In this context, a workshop was organized in Ljubljana on 2008 [29]. Again, it clearly appeared that different approaches existed in Europe for the acoustic classification of road surfaces. The output of the seminar was the formal establishment of a stakeholder group in order to move forward in the process of harmonisation or standardisation of the subject. This group named NCAG (Noise Classification Advisory Group) met twice, in 2008 and 2009, and at present, a formal connection to relevant CEN working groups (CEN/TC227/WG1 and WG5) is being sought.

Noise barriers

There is no regulation for noise barriers in Europe. The decision to build one, together with its dimensions and architectural choices is left to the road authority. In general, a barrier will be installed where predicted or current noise levels are high. Size is determined by a predicting calculation of sound attenuation and whether or not an absorbent material is needed.

The only harmonised documents are CEN standard methods of the EN 1793 series [30] for the measurement of acoustic properties of barriers. These properties are:

- Sound absorption that can be characterised in laboratory in the same way as absorbent material for building construction, and on site after construction.
- Sound transmission that can be tested on site to detect mounting failures or leakage.
- Sound diffraction on site by added devices on the top of barriers.

The ISO 10847 standard describes a method for the evaluation of sound insertion loss of sound barrier. The CEN working group is considering such a method but has adopted the ISO method for the present.

5.2.1 Gathering information

A task of TYROSAFE WP2 is to review the existing practice in EU member states concerning noise emission policies. Following a similar scheme to that used for skid resistance (see paragraph 3.2.1), a questionnaire was written to collect information and sent to the same countries, including the 27 EU member states. The questionnaire also included a part related to rolling resistance, as the experts concerned are often the same.

The questionnaire on noise emission included questions on national requirements regarding road traffic noise emission and different contributors (tyres, vehicles, pavements, etc). Then the questions focused on the assessment of noise characteristics of road surfaces, the definition of a low noise road surface, the existence of labelling procedures, of specifications in tendering procedures, of procedures for checking the conformity, of monitoring procedure. Seventeen countries completed the questionnaire, including 15 EU and 2 non-EU countries. In the following analysis, only EU countries are considered. It is emphasized that in this kind of exercise, the choice of objective experts in each country is fundamental. According to their field of experience, some bias may be introduced in the answers and it must be as limited as possible.

While this work was going on, it was found out that a similar comprehensive survey had been carried out in 2006-2007 in the context of the Conference of European Directors or Roads (CEDR). CEDR has appointed a noise expert group with the objective to facilitate knowledge sharing on noise management and abatement issues among the European National Road Administrations. The group carried out a questionnaire survey and reported the analysis in a comprehensive report in May 2008 [39].

The questionnaire developed in within TYROSAFE concentrated more specifically on the ways in which road surface properties are considered in policies or regulations, on all levels of road network. The CEDR questionnaire of CEDR concentrated only the national road networks. The coherence between the outputs from both questionnaires will be discussed at appropriate points through this report.

5.2.2 National requirements for road noise mitigation

In the survey, 47% of EU countries declare that they have no specific national requirements regarding road traffic noise emission other than Directive 2002/49/EC. This figure drops to 41% when the two non-EU countries are included. This figure seems high compared with the CEDR survey where only 5% of members declared applying no noise limits for new national roads and 33% for existing national roads. However, for the remaining country with noise limitations, main conclusions are similar to CEDR survey. Noise indicators are different, however. Although L_{Aeq} is the most used, the periods covered are not similar: 4 out of 8 countries use day and evening periods only, one country uses day, evening and night periods, one uses the L_{den} in addition and one uses the L_{den} only. Finally, one country uses another indicator. Little information has been asked about the indicator and many more details on this subject can be found in the CEDR report [39].

It can also be concluded from the questionnaire that EU-countries put different limit values in their national requirements.

All countries requiring noise limits assess them by means of calculation. Different calculation tools are used.

Only four countries out of eight assess the situation after road construction by site measurements. These measurements are in general noise emission evaluation at façades of buildings according the standard method ISO 9613-1 and 2, except in one case where a national procedure is applied.

The questionnaire also looked at the policies on separate contributors to road traffic. 40% of EU countries declare not to have any specific policy. 40% of countries have policies related to noise barrier construction; around 13% have policies on traffic management actions and in particular speed limits. Only one country has a specific policy active for the promotion of particularly low noise tyres, in reference to EU limits. The threshold is fixed to more than 4 dB reduction compared to tyre-noise limit. This is a stimulation scheme for new passenger car tyres the expected benefit of which is estimated at 2 dB on the long term. One EU country has a policy related to façade insulation, one has a policy related to low-noise trucks designation and another three countries have general policies related to noise emission and involving a combined used of contributors. They all appear under the "Other" group in Figure 5-1.

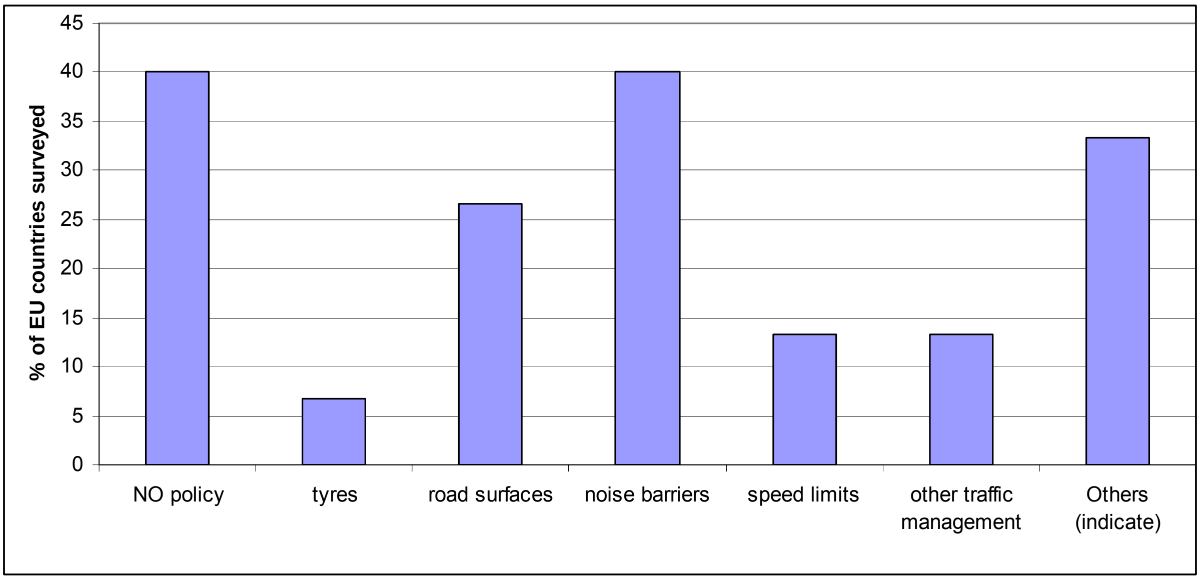


Figure 5-1: EU Members having requirements related to road noise mitigation (set of 15)

5.2.3 Road noise measurement methods

An important part of road noise mitigation is the harmonisation of evaluation methods. This is done through the standardisation of measurement methods.

For the measurement of road traffic noise emission at façade, people usually refer to the international standard ISO 1996-1 and ISO 1996-2 [31][32]. These are the references recommended in the EU Directive that also specifies the location of measurement points. The measurement principle consists in making long duration measurements of noise levels – at least one day – in front of exposed façades. The results are expressed in terms of $L_{Aeq\ day}$ (from 6:00 to 18:00), $L_{Aeq\ evening}$ (from 18:00 to 22:00), $L_{Aeq\ night}$ (from 22:00 to 6:00), and finally to the L_{den}, an indicator gathering the three periods and applying a penalty of 5 dB for the evening period and a 10 dB penalty for the night period.

More locally, for the measurement of noise performance of a road surface, there are two basic types of methods: the pass-by methods and the close proximity

• Pass-By method (SPB and CPB)

This is the most extensively used method for measuring tyre-road contact noise. The A-weighted maximum sound pressure level L_{Amax} of vehicles running at steady speed is measured by a microphone located at 7.50 m from the road axis and 1.20 m above the ground. For road surface characterization, this measured noise must be as independent as possible of the tire and vehicle characteristics. Thus, measurements are taken from a large number of vehicles (around 80 per each category) in a real traffic flow. Then a statistical analysis is performed, by calculating a logarithmic regression of the L_{Amax} vs. speed data. With this regression curve, it is possible to define the A-weighted reference sound pressure level at the reference speed, which is, after correction for temperature effects, the reference indicator for acoustic performance of the road pavement. The reference speed depends on the type of vehicles (passenger car or dual or multi axle trucks) and the type of road (highway, main road, local road...). The measurement procedure called Statistical Pass-By method (SPB) is described in an international standard NF EN ISO 11819-1 [33]. A variant of this method is called "Controlled Pass-By" (CPB). The main difference is that test vehicles driven in controlled conditions are measured instead of vehicles picked-up from the traffic. Four different tyre/vehicle configurations are usually defined. This method has been defined in French and German standards. It is essentially used when the road to be tested is not open to the traffic.

Figure 5-2: SPB measurement

The (SPB) method is appropriate for the characterization of road noise environment, because all types of vehicles in a real traffic can be included. However, this procedure provides a "spot" evaluation at the specific location of the microphone. It is not possible to check pavement heterogeneity. Furthermore, demanding site conditions are needed (no obstacle or reflecting surface in the vicinity, no slope, no curve…) that makes it almost impossible to operate in dense urban areas, where noise problems are the most critical.

• Close Proximity method (CPX)

In this method, two or more microphones are placed very close – typically 20 cm from the tyre side wall - to the tyre for measuring near-field tyre noise emission while rolling. The tyre can be either one of the wheels of a normal vehicle or one of a special trailer. In either case, severe protection measures must be taken to prevent the measurement to be influenced by wind turbulence, noise from traffic and noises from the vehicle. An international ISO working group (ISO/TC43/SC1/WG33) is currently drafting the specifications of the methodology in a document referenced ISO CD 11819-2 [34]. The most critical issue concerns the choice of the reference tyre(s). It has been decided that the selected tyre(s) will be described in a separate Technical Specification (TS 11819-3). At the time of writing, the proposed reference type is a Uniroyal Tigerpaw 225/60 R16 tyre. This is used in the automotive industry as a standard reference test tyre and is specified in ASTM F2493-06 [35]. Thus, it is also sometimes referred to as the "ASTM" tyre or the SRTT ("Standard Reference Test Tire"). In addition, a second tyre has been selected, Avon Supervan AV4 195-R14C tyre. It is a passenger car tyre that is expected to have the acoustic behaviour in terms of emission of a typical truck tyre.

Figure 5-3: Examples of CPX test vehicle (left) and trailer (right)

Although it is not yet standardised, the CPX method has been increasingly used over the past few years. Quite a number of CPX vehicles or trailers have been developed in Europe, all different. Several Round Robin tests have been performed and showed significant discrepancies. This was obtained however with a different tyre specification as the one mentioned above, and a new experimentation should be organised with this new configuration.

The main interest of the CPX method is that it can be easily implemented, even in urban situations, as it is not disturbed by acoustic reflections of nearby buildings like the pass-by procedure. Another advantage is that the road surface can be tested in a continuous way while the pass-by method is only representative of the spot facing the fixed microphone.

• Comparability of SPB/CPX

Because the microphone is set close to the tyre, the CPX method lacks realism. SPB gives a better evaluation of environmental noise effect of road pavement as it involves sound propagation up to the road side. By use of propagation models, it is possible in some simple cases, to estimate from SPB measurements the equivalent sound pressure levels (L_{Aeq}) at façade of buildings.

But CPX has several advantages making it easier and cheaper to implement and better adapted to road conditions.

Thus, it appears that both methods are complementary and should be used in conjunction for the characterisation of pavement noise performances.

Several experimental studies have been carried out in Europe to correlate both measurements. However, because the reference tyre(s) for SPB are not fully adopted yet, these correlations are still questionable. There is no agreement on the relation that should be considered to link both methods.

• Additional auxiliary methods

Auxiliary measurement methods for determining noise-relevant surface characteristics are sometimes mentioned. It is expected that, because they are easier to implement, they can be used as “proxi” measurement methods, and thus replace tyre-road noise measurements for the evaluation of noise performances of road surfaces. They can also serve as complements to tyre-road noise measurements. The main characteristic is texture. Sound absorption is another parameter relevant for porous pavements, and it is expected that mechanical impedance is a relevant parameter for very elastic pavements.

- *Surface texture measurement:*
  The relevant texture information to be correlated with noise must cover complete macro- and megatexture ranges. The texture profile must then be expressed in terms of spectra. Measurements and analysis are defined in the international standards and technical specifications for the ISO 13473 series [36].

- *Sound absorption measurement:*
  The sound absorption coefficient is the fraction of sound energy absorbed by a material when a sound wave is reflected by its surface. Most low-noise pavements produce sound absorption. The measurement of this coefficient is described in the ISO 13472-1 standard [37]. The measurement is static and the road has to be closed to traffic during the measurements.

- *Mechanical impedance measurement:*
  Only a few works have been devoted to this parameter, and a couple of methods have been investigated by researchers [38]. The real issue is to measure a relevant parameter (direct impedance or modulus of elasticity) that can be linked to noise emission. At the moment, this parameter is not taken into account in predicting models.

5.2.4 Noise labelling of road surfaces

Noise labelling of road surfaces can be aimed at for three applications: 1) guidance for decision-makers, 2) correction terms in calculations and 3) contractual specifications. It has been reported [28] that 12 European countries use different classifications systems, but these systems are neither comparable nor exportable across borders. A detailed description of classification systems in many countries including Japan and USA can be found in Reference [8]. A classification scheme has been proposed in EU FP5 project “SILVIA” [38]. It is based on SPB measurements of different sites with the same type of road surface. It is associated with other measurements such as CPX and texture measurement

In the present project, questions about existing national labelling procedure were part of the survey questionnaire. The answers show that 40% of EU members do not have a classification system, 40% are considering having one and the remaining 20% (3 out of 15) have an active system. The difference with the COWI report [8] can be partly explained by the different set of countries studied, but for a few countries, it was noted that they claimed to have a classification system in 2006 but do not anymore in 2008, which is rather doubtful.

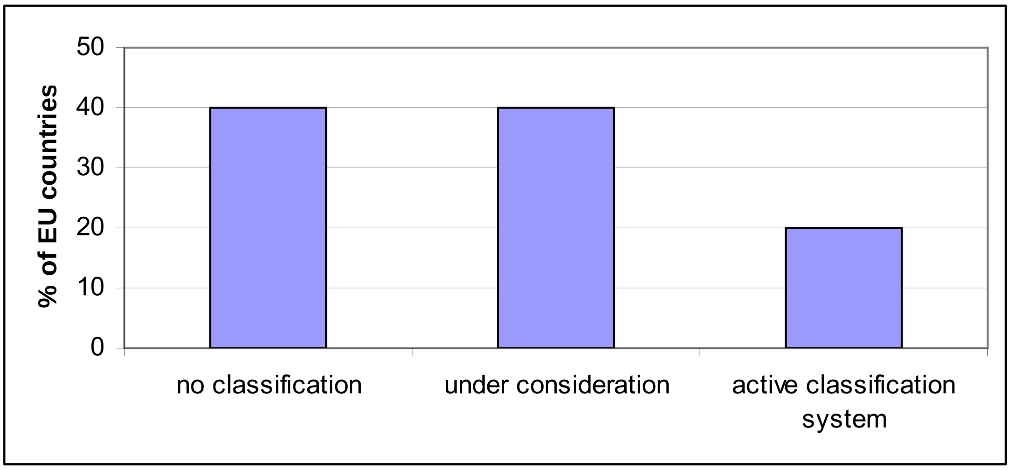


Figure 5-4: EU Members with a noise classification system of road pavements (set of 15)

The conclusion regarding the comparison of classification system is coherent with Reference [38], i.e. when they exist the systems are not comparable at all. They are all based on SPB measurements but with significant difference in the use of the results. In one country, the result is compared with a calculated reference and an index is derived. In another country, SPB is measured at a non-standardised microphone position (5 m high instead of 1.2 m), and the results are compared to the same measurement on a reference dense asphalt DAC 0/16. Finally, in the third country, the system is based on both CPB and SPB measurements. In the three countries having an active classification system, 10 to 34 labels have been delivered to date.

Among the countries for which such a system is under consideration, half of them are testing a system, or at least have an idea of what they will try to implement. More precisely, seven out of fifteen EU countries (nearly 50%) have a current definition for low noise pavements. This actually includes those having an active system of classification and those considering one. But here again, the definitions are not comparable. Some refer to CPX measurements, others to SPB measurements or even L_{Aeq} measurements (at façade). The indicators are usually country specific, and refer to different speeds. Finally, some countries define classes of low noise pavements according to their types; others define only noise properties.

It can be concluded that although more EU members seem aware of the importance of a classification system of road surfaces and are willing implement one, and although a

European consortium has proposed a classification scheme (“SILVIA” [38]), there no common procedure that would help the circulation of products through the European market.

5.2.5 Assessment of noise characteristics of road surfaces

The classification system proposed in SILVIA is actually a complete scheme associating labelling (or type approval) and Conformity of Production (COP) checks. But in terms of COP, the situation is less advanced than for labelling. A significant amount of EU Members insert noise specifications in tendering procedures, but it is usually on a case by case basis and for specifically low noise pavements. Only one country claims to use it more systematically. More than 33% of the countries never put any noise requirements in tendering procedure, even for low noise pavements. When noise specifications are introduced, they are required usually at the initial stage, just after the work completion or one to two months after the completion. However, in a few cases, the specification can be required later, one, two or even five years after completion. In one Nordic country, the check is systematically performed after one year. This is important because the noise properties of road surfaces can be altered after some time, and the preservation of noise performance is essential for noise environment. However, long term requirements may be a challenge for road companies as the ageing effect of road surfaces is not fully predictable and depends on external effects such as traffic conditions and road maintenance, especially in winter.

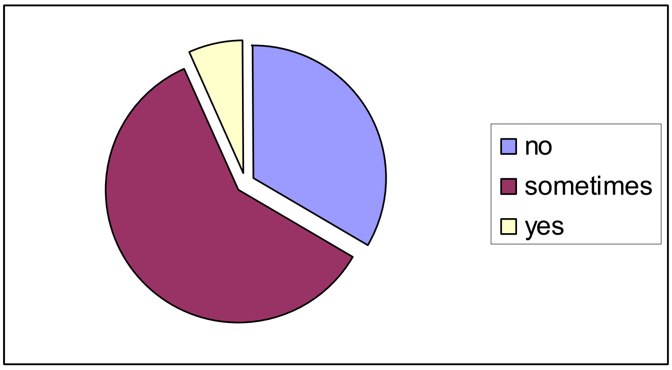


Figure 5-5: EU Members where noise specifications are introduced in tendering procedures (set of 15)

The survey shows that three countries out of fifteen have an active COP procedure to check the acoustic requirements in the case they have been specified in tendering procedure.

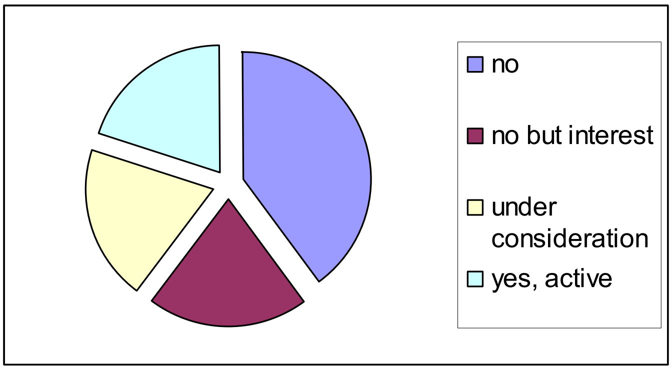


Figure 5-6: EU Members where a procedure for the check of conformity of production of acoustic properties is active (set of 15)

40% of the countries have no interest in a COP procedure, 20% do not have a COP procedure but are interested in the subject, and 20% do not have an official procedure yet but are considering or testing one. All of them rely on CPX measurements, but two EU Member States associate SPB measurements. Reference speeds are different between countries.

Most of the six countries practicing a COP procedure have introduced a tolerance. This ranges from 1 to 2 dB, but one country does not apply any tolerance. Regarding the penalty, rules are also different from one country to another. Some countries did not define the rules. Usually a financial penalty is applied if the requirement is not met. In one country, the section is rebuilt if the measured result is 1.5 dB or more over the requirement and a financial penalty is applied if the measured result is between 1.0 and 1.5 dB over the requirement. One country applies a bonus in case the performance is 1.5 dB (or more) lower than the required limit.

5.2.6 Monitoring of noise properties of road surfaces

Monitoring of noise properties of road surface can provide important information on the noisiness of roads surfaces of a network, on their evolution over time, and can assist road owners in their strategy for maintenance. 40% of EU members do not monitor the noise properties of road surfaces; the other 60% do it on some networks, on a case by case basis. One country mentioned that this monitoring can be specified in the tendering procedure. Four EU members mentioned the method: surprisingly, only one country uses CPX; another uses SPB/CPB; another SPB only but mentions that CPX is used more and more; finally, one country uses measurements at façade for the monitoring. Measurements are usually repeated every year. Measurements at façade are repeated every five years. The main application of this monitoring is the realisation of a data base, either public or belonging to the road owner. It can also be used for research purposes. One country uses the monitoring results in making decisions about pavement replacement.

5.3 Further needs

5.3.1 Measurement methods

In terms of measurement methods, the standardisation process of tyre road noise measurement must be completed rapidly. This should happen soon with the submission of Draft ISO 11819-2 (CPX) and the definition of reference tyres. New extensive round robin tests should be organised in the near future to check whether the use of only one or two reference tyre(s), but with stricter specification, would lead to a better reproducibility of the CPX method.

The ISO 11819-1 (SPB) method is currently under revision. This revision should aim at making the method more applicable, of course without losing accuracy. More work should be done to correlate it with CPX, presumably by using modelling approach and experimental check.

Regarding proxy methods, it must be emphasized that the method for measuring sound absorption is static and can only be performed on untrafficked roads. Thus, the measurement is rarely implemented on site. Attempts have been made in the past to develop a mobile system for the measurement of sound absorption, in the UK and in Italy. However, more research work seems needed before a relevant and accurate method, easy to implement on site, can be provided.

Finally, the relation between the proxy parameters and tyre-road noise should be investigated more fully, and a common predicting model should be proposed.

5.3.2 Harmonized systems of classification and COP

Once more, the need of a harmonised classification scheme of noise performances of road surfaces can be observed. This should concern both classification and conformity of production. In this scheme, long term performances should be taken into account. This will require the integration of research results on the evolution of noise over time.

5.3.3 Complementarities between noise and other surface characteristics

Making the link with the other surface characteristics, it is acknowledged that noise requirements will not go against safety and energy saving requirements.

First, speed reduction is not only beneficial for noise but also for safety, CO_2 emission and energy saving.

Regarding safety and skid resistance, it has been observed that there is no antagonism between low noise properties and high skid resistance, at least at low speeds. For instance, the use of very small aggregate in the mix (6 or even 8 mm) will produce noise reduction, but will not deteriorate skid resistance due to the increase in the number of contact points. Research is ongoing to confirm that there is no significant deterioration in skid resistance at higher speeds due to reduced macrotexture on surfacings where small aggregate sizes are used.

6 Conclusions

The three road surface parameters investigated in this report are at different stages concerning policies and standards.

Regulation of noise emissions started in the 1970s with an EU directive. Noise labelling of road surfaces is currently under consideration in many EU countries. Around two thirds of the EU countries have introduced noise specifications at least in some of their tendering processes. Conformity checks are done by almost a quarter of the countries, another quarter is considering doing so.

Standards for measurements exist, but there is still work left to do for both CPX and SPB methods and their correlation. Round robin tests are recommended then. The measurement of acoustic properties of noise barriers has been harmonized by a CEN standard, but there is no further regulation on noise barriers in Europe.

Skid resistance shows a different picture. Although there is a common understanding that it is an important safety parameter, there is no formal European policy for managing skid resistance. In the member countries, the status of policies shows a large variation from “no policy at all” to sophisticated risk-related approaches for different road sections. Generally, the higher level networks are more widely and better covered than low level networks and urban roads.

Measurement methods for skid resistance are not harmonized either. The only internationally standardized method is the Pendulum test – a device of little use for network level skid resistance monitoring. Due to the large variety of devices used, a comparison of measured values in different countries is not possible at present. Harmonization efforts have been ongoing for almost twenty years now, but the relevant CEN standard is still in draft form and does not fully covering all devices currently in use. (TYROSAFE Deliverable D05 is a detailed analysis and discussion of the subject harmonisation of skid resistance measurement methods).

Rolling resistance is the least regulated of the three parameters being covered in TYROSAFE. The reason for this might be that rolling resistance has long been regarded as tyre property only. In that context, significant improvements have been achieved. Rolling resistance as influence by road surface properties remains a topic of research. Not all influencing parameters have been identified yet. Therefore, different measurement principles exist and no harmonization has been achieved to date. With increased emphasis on CO_2 emissions, the obvious correlation between rolling resistance and fuel consumption has come into focus. With optimized road surfaces, savings in fuel and emissions are possible. This will strengthen the efforts for a regulation of rolling resistance of road surfaces in future years.

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Annex I: Safety relevant aspects of skid resistance – literature review

A literature survey regarding the safety relevant aspects of skid resistance has been carried out. It is common sense that skid resistance has an impact on road safety, but the influence is quite difficult to quantify. Aim of the literature review was to find publications that investigate and quantify skid resistance level and accident risk.

"Friction measurement methods and the correlation between road friction and traffic safety", Carl-Gustaf Wallman, Henrik Aström, VTI meddelande 911A, Sweden, 2001

Abstract:

"Doubtless, there is a strong correlation between road friction and accident risk. The problems arise when we demand a more detailed view of that correlation. The aim of the project behind this report was to gather information about the different friction methods in use and about published quantitative relations between road friction and accident risk.

Regarding friction measurements, every country has instruments and methods of its own, and the friction values reported from different international investigations are therefore not directly comparable. Work on harmonisation of friction measurements is in progress.

Road friction is very important for traffic safety, but it is difficult to single out the effect of poor friction on the accident risk. Drivers adjust their driving behaviour depending on many factors, e.g. the appearance of the road environment, the weather, the sound from the tyres, and the sliding and skidding movements of the vehicle.

For dry or wet bare roadway, however, the conditions are comparably homogeneous, and several studies show dramatic increase in accident risk when the friction numbers decrease below certain threshold values,

For winter circumstances there are few and unreliable estimations of the correlation between accident risk and friction."

Comment:

"The relation between friction and accident rate is certainly no easy problem to explain. Many different factors pertaining to the road environment – in addition to the friction – affect the driver behaviour. The driver behaviour variability is of great importance for the accident rate.

The complexity of the problem is especially pronounced at winter conditions, as has been found in this review, similar-looking roadway conditions may have very different friction numbers. Also, the friction may vary both across and along the road. Friction conditions are much more stable at dry or wet bare road surface.

Surveys of winter accident rates thus imply very varying results, but always with much larger risks than at bare road conditions. Future studies must have much closer control of factors as roadway conditions, friction coefficients, and exposure etc. to make a more detailed assessment of accident rates possible. This involves frequent observations of the roadway condition and extensive friction measurements, as well as much more detailed description of each accident (crash investigations).”

“Crash risk relationships for improved safety management of roads”,

Cenek, P.D.; Davies, R.B., New Zealand, 2004

Introduction:

“Each year since 1997, Transit New Zealand surveys the entire sealed length (10.736 km) of New Zealand’s State Highway network for road condition (roughness, rutting, texture and skid resistance) and geometry (horizontal curvature, cross-fall and gradient). In addition, to measure the traffic demand imposed on the State Highway network, Transit New Zealand maintains estimates of traffic flows. The flows are typically estimated from individual counts over one-week periods. The traffic monitoring sites are distributed throughout the length of the State Highway network and are counted one, two or three times a year, with some sites counted on a continuous basis. The Land Transport Safety Authority (LTSA), through its crash analysis system (CAS), maintains data on all fatal and injury road crashes attended by the New Zealand Police. The crash data includes details about the location, time, distance, drivers involved, casualties and crash circumstances and cause factors.

These data sources, when combined, enable statistical modelling techniques to match crash rate with road characteristics. Such an analysis allows a broad-brush approach to the entire State Highway network, which is in contrast to studies of individual sites, such as black spot sites. Generally, crash rates in New Zealand are too low to allow consistent conclusions to be drawn about the relationship between road characteristics and road crashes from before and after treatment comparisons at individual crash sites. The kind of analysis presented in this paper, by using data from the whole State Highway network, in effect, combines the data from individual potential crash sites, including those where there were no crashes, and so provides estimates of crash risk that can be used with a degree of confidence to evaluate the cost-effectiveness of road geometry and road condition related safety interventions.

However, such an analysis cannot take into account all special features of each section of road, such as specific hazards, and so provides only an average estimate of crash risk.

This paper summarises the results of two analyses of state highway data for the period 1997 to 2002. The first analysis utilised one and two-way tables to provide a preliminary indication as to what road condition and road geometry factors affect crash rate. The second analysis involved Poisson regression modelling to better identify the important predictor variables and how they influence crash rate. The ability to reliably predict crash rates is very important in the safety management of road networks because it can help in identifying hazardous locations, locations that require treatment and locations where deviations (either higher or lower rates) from expected (predicted) warrant further examination.”

Effect of skid resistance:

“A previous study (Cenek et al, 2002) using paired crash site analysis, which considered changes in the number of crashes and road surface skid resistance at two different points in time at specific crash sites, found the 95% confidence interval for the crash rate reduction factor per 0.1 increase in SCRIM Coefficient to be:

- (1.2, 1.7) for a comparison of 1995 and 1998 data
- (1.1, 1.8) for a comparison of 1995 and 1999 data

Applying the simplified model for the ‘Wet Selected Crashes’ data subset with only a linear function of SCRIM Coefficient gave the 95% confidence interval for the crash rate reduction factor per 0.1 increase in SCRIM Coefficient as (1.4, 1.7). Since this is in general agreement with the previous estimates, there can be a degree of confidence that the simplified model can provide estimates of crash rates that are sufficiently accurate for safety management purposes.”

Conclusions:

“The Poisson regression model presented appears to work in a reasonably satisfactory way and produces results that, for the most part, make sense. For example, curvature has a strong effect on crash rate as expected. There is also a strong effect for skid resistance and a weaker effect for lane roughness. However, as this has been a retrospective analysis (as opposed to a designed experiment), it is not possible to be sure that the predictor variables used in the regression analysis are really the ones affecting the crash rates. In particular, it is likely that ADT is a general indicator of road quality and this is leading to the observed drop in crash rate as ADT increases.

The simplified model in its current form is sufficiently robust for the following four applications:

1. To improve the understanding of the factors affecting crash risk and the relative importance of different factors.

2. To improve the management of the highway network by estimating the effect on crash numbers of changes in standards for curvature, skid resistance and roughness.

3. To identify black spot regions, where, because of factors not included in the model, crash rates are much higher than predicted by the model. It may also be possible to detect white spots where crash rates are lower, although this is less likely to be successful.

4. To use the model to help evaluate the effect of an actual change in road construction or management policy in a Transit New Zealand administration region by comparing the observed and predicted number of crashes.”

“Incorporating Road Safety into Pavement Management: Maximizing asphalt pavement surface friction for road safety improvements, Draft Literature Review & State Surveys”, David A. Noyce, Ph.D., P.E., Hussain U. Bahia, Ph.D., Josué M. Yambó, Guisk Kim, Midwest Regional University Transportation Center, Traffic Operations and Safety (TOPS) Laboratory, USA, 2005

Introduction:

“Traffic crashes and the associated injuries and fatalities continue to be a significant problem for transportation professionals. In 2003, 42.643 traffic fatalities and almost 2.9 million injured were reported in the United States as a result of over 6.3 million crashes. The Federal Highway Administration (FHWA) Region 5 states (Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin) accounted for 6.352 of the total transportation fatalities, approximately 15 percent of the national total. In 2002, 43.005 traffic fatalities were reported in the U.S., approximately 0.8 percent higher than the 2003 data. The 2003 fatality rate dropped to a low of 1.48 fatalities per 100 million vehicle miles of travel (HMVMT). Similarly, the injury rate fell to 100 injuries per HMVMT in 2003. When considering the state by state totals in Region 5, only Ohio observed a decrease in total crashes; with Wisconsin observing the largest increase at six percent. The overall crash incidence reduction in 2003 could be a result of improved safety measures implemented in recent years, or simply a result of random variability. Although safety related implementations, ranging from stricter safety laws and public awareness campaigns to roadway and traffic control device improvements represent an undeniable progress for crash reduction, total crashes and fatalities continue at unacceptable rates. This is particularly true when one considers that the current fatality rate equates to one death every 12 minutes, or approximately 117 fatalities each day.

In addition to the pain and suffering cost that crashes bring to society, traffic-related incidents also have a significant cost to our economy. As of year 2000, the cost of motor vehicle crashes to the United States economy was estimated as $230.6 billion.

This figure increases from year to year – money that could undoubtedly be better used in others areas if the number of traffic-related crashes could be reduced.

Individuals who study traffic crashes know that each crash is a complex event involving a variety of factors. Traffic crashes can be considered as unique, random, multi-factor event always proceeded by a situation in which one or more persons have failed to cope with their environments. Road crashes are rarely caused by a single factor. Most often, contributing factors are categorized by driver, vehicle, and roadway, with each containing multiple sub-variables.

Because of this complexity, and the difficulty identifying the human factors elements, i.e., human behaviour at the time of crash, most crashes are considered to be the result of driver error. Error can include many different human factors related issues including fatigue, impairments due to intoxication, inexperience, and distraction. The problem lies in the fact that eliminating driver error is considered an insurmountable task.

Therefore, the role of the transportation professional is to improve the roadway system such that the consequences of driver error are minimized. Safety evaluations involve a comprehensive analysis of all prevailing factors at the time of crash, including those of the pavement surface, to determine the countermeasures (i.e., safety improvements) necessary to prevent crash reoccurrence.

The implementation of road safety improvements to reduce the number of crashes and fatalities on our roadway system has been extremely effective over the years. Nevertheless, when eliminating crashes is not possible, reducing the severity of a crash is an important goal. In this sense, more attention is required to other elements of the roadway system that could be a contributing factor in traffic crashes. One such contributing factor that has been discussed and evaluated over the years is road surface characteristics, specifically skid resistance (friction) of roadway pavements under various weather and aging conditions.

Nonetheless, a recent paper has suggested that little has been done to incorporate pavement management and maintenance into roadway safety evaluations. Assuring that sufficient skid friction is available under all weather and pavement types, considering the vast array of construction methodologies and roadway material is of great importance and should be appropriately considered in this effort to reduce traffic crashes."

Summary of findings (literature review):

"There is evidence to suggest that low skid resistance results in increased numbers of wet pavement crashes. Some studies have found a linear relationship of increasing wet weather crashes rates with decreasing skid resistance. Other studies suggest that the relationship may be non-linear, with the slope increasing with decreasing skid resistance. The common point is that a decrease in pavement skid resistance will likely result in an increase in crash risk.

Pavement management strategies need to be developed to integrate skid resistance in the mix design and safety considerations. Maintaining high levels of skid resistance is important especially where there is frequent braking in response to unexpected events, such as on the approaches to intersections.

Skid resistance is an important consideration in highway safety. There exist sufficient studies to indicate that two main characteristics of pavement surface affect skid resistance: Micro-texture and macro-texture. The role of each in providing sufficient friction varies depending on the speed. In addition, the materials variables that affect each type of texture are different.

It is well recognized that micro-texture is a function of the initial roughness on the aggregate surfaces and the ability of aggregates to resist polishing. A selection of aggregate mineralogy and measuring its polishing resistance has been used widely as a measure of potential micro-texture. Micro-texture is considered a controlling factor for skid resistance at low speeds but not high speeds. Because of the difficulty of quantifying aggregate roughness and the resistance to polishing, micro-texture is best measured using surrogate tests that allow measuring wet friction at low speeds using small scale devices such as the British Pendulum and the Japanese DFTester. It is indicated in many studies that skid coefficient measurements correlate mostly with micro-texture but not macro-texture.

There are well-developed models for wet pavement friction (skid resistance). The most widely accepted models indicate that pavement friction, which is a measure of the force generated when a tire slides in pavement surface, is a string function of speed (velocity of the tire to surface). Friction increases from zero (rolling tire) to a peak value and then decreases rapidly as the speed increases. When a brake in a vehicle is first applied, the slip speed is initially high and if breaking continues after the looked wheel condition is reached, the vehicle speed will be equal to the slip speed decreases until vehicle stops. It has been shown in experimental studies that good micro-texture results in high friction at low slip speed (< 60 km/hr) but low friction at high speeds. Good macro-texture, on the other hand, results in low friction at low speeds but higher friction at high speeds (> 60 km/hr). To provide for sufficient friction it is important to design for good micro-texture and good macro-texture.

Macro-texture is mainly a function of surface texture, the large-scale roughness that is present due to arrangement of aggregate particles or the grooving created intentionally on surface. The importance of this surface roughness is it allows reducing the thickness of the water film during wet conditions and thus reduces the possibility for hydroplaning. Macro-texture can be measured by a volumetric method using sand or glass beads, or by using a laser profiler. The volumetric method can be used in the laboratory as well as the field and is considered a practical method but requires some time. The laser method can be done at reasonable travel speed and thus is suitable for continuous pavement network monitoring.

Based on the literature review conducted in this project, it appears reasonable to attempt the development of a mixture design procedure that is considerate of skid resistance based on measuring micro-texture and macro-texture.

The micro-texture will be either estimated from mineralogical information and/or polishing resistance of aggregates. It is also possible that a laboratory friction measurement using the British Pendulum will be considered.

The macro-texture will be measured using the sand patch method applied on laboratory prepared samples. A model will be developed to estimate mixture surface friction (MSF) as an indicator of potential mixture skid resistance. Acceptable limits of MSF will be based on correlations of the MSF values with actual full scale skid testing in the field as well as traffic accidents data."

"Skid Resistance Aspects and its Influence on Braking Decelerations of Passenger Cars", DI Dr. Peter Maurer, bmvit, Road Research, Publication No. 564, Austria, 2007

Abstract:

"The skid resistance of the road surface is essential for road safety. Safe acceleration, deceleration and steering manoeuvres can be performed only if the traction supplied by the road surface is at least as large as the traction required by the vehicle as a result of a specific driving manoeuvre. Maintaining a high level of skid resistance is therefore one of the major tasks of road operators when it comes to providing a safe road infrastructure for road users.

A large number of studies have proven that poor skid resistance leads to a higher accident probability.

Road Traffic Regulations (STVO) as well as road planners and road operators require that drivers must be able to bring their vehicle to a safe stop on all roads within the stopping sight distance. An aggravating factor is that the driver cannot judge the degree of skid resistance of a wet pavement by visual or sensory means and is thus not able to adapt his/her driving behaviour to the degree of skid resistance, e.g. in the case of road ruts.

In Austria, skid resistance measurements are carried out at regular intervals using the high-performance road surface tester RoadSTAR (Road Surface Tester of arsenal research). The skid resistance data measured by RoadSTAR are transformed into pavement condition data using scaling functions based on the Austrian skid resistance evaluation method dating from 1996. This method was defined on the basis of the friction coefficients measured for the pavements of Austrian motorways and main roads at that time.

The skid resistance classes were specified 1996 based on the statistical distribution of the measurement values as follows:

- Boundary very poor/poor: cumulative frequency limit at 95 %
- Boundary poor/sufficient: cumulative frequency limit at 90 %
- Boundary sufficient/good: cumulative frequency limit at 70 %
- Boundary good/very good: cumulative frequency limit at 30 %

The braking deceleration of a car achievable at a specific skid resistance measured with the RoadSTAR measuring system has not been investigated so far. The Austrian regulations RVS 03.03.23 and RVS 03.05.13, however, specify a minimum braking deceleration of 5 m/s² for determining the required sight distance. It was therefore necessary to determine the skid resistance level required to achieve this minimum value of 5 m/s² under different conditions, e.g. different tyres, braking systems, water film thicknesses etc.

This work focuses on modelling the stopping process based on the results of RoadSTAR skid resistance measurements and full braking tests with passenger cars in order to document the relationship between skid resistance (μ-RoadSTAR), speed and stopping distance. This model is based on practical and simple assumptions and does not take specific parameters into account, such as e.g. the vibration behaviour of the vehicle during braking. This was not the subject of this work. The findings from this study were used to adapt the Austrian skid resistance evaluation method of 1996 based on measurable quantities.

The μ-RoadSTAR skid resistance values allow the stopping distances for different road sections to be calculated by varying the reaction time, speed and vehicle parameters. These calculations may in future also assist in solving safety relevant problems. For example, the stopping sight distances of existing roads could be examined by comparing them with the actual stopping distances based on existing skid resistance levels. Since skid resistance is measured within the scope of periodical measurement campaigns, the safety potential of roads could be assessed at regular intervals (Road Safety Inspection). The equations and diagrams developed will also make it possible to determine the maximum safe speed on wet road surfaces based on the existing skid resistance levels and sight distance. Traffic legislation such as speed limits can thus be substantiated by actual braking and stopping distances.

The results of this study can be applied not only in the large area of traffic planning and road safety but also in transport telematics projects. Potential applications include, for example, intelligent speed adaptation and projects related to “cooperative systems”, where the recommended operating speed is calculated from pavement condition data and displayed to the driver. As another example, an on-board system could compare the braking or stopping distances with the current gaps between vehicles and warn the driver if he/she gets too close to the car in front.

The present study also documents the latest findings in the field of skid resistance. It should, however, be noted that the pavement conditions "slush" and "snow and ice covered roads" were not taken into consideration."

"Sichere Straßen: Regeln und Erkenntnisse für Straßenbau und Verkehrstechnik", Schriftenreihe der Straßenbauverwaltung, Baden Württemberg (Innenministerium), Heft 2, Deutschland, 1989

„Safe Roads: Rules and expertise for road construction and transport technology"

Specific statements regarding skid resistance and road safety:

- Skid resistance: The accident rate on wet road surfaces in comparison with all accidents is increasing clearly with a decreasing skid resistance value → significant results can be shown at skid resistance values lower than 0.26 (extraordinary high accident rate) and over 0.35 (low accident rate)
- Texture: Analysis, which quantity correlations between micro-texture or macro-texture and road accidents, are not published in that time

"Merkblatt zur Erhöhung der Verkehrssicherheit auf Motorradstrecken – MVMot", Forschungsgesellschaft für Straßen- und Verkehrswesen, Germany, 2007

„Bulletin for increasing road safety on motorcycle routes"

Specific statements regarding skid resistance and road safety:

- Skid resistance: decisive influence on the adhesion coefficient between the tyre and the road surface → especially sudden discontinuities in the skid resistance values of the surface decrease the maximum transmittable braking- and side-forces between tyre and road surface → example: bituminous fillings, „Polishing Effect", pot holes, cracks in the pavement, etc.

"Bericht des Verkehrsauschusses über den Antrag betreffend die Verbesserung der Verkehrssicherheit durch Erhöhung der Griffigkeit österreichischer Straßen", Vienna, 2001

„Report of the transport commission about the proposal regarding optimizing road safety by increasing of the skid resistance on Austrian roads"

Specific statements regarding skid resistance and road safety:

- Every fifth of the 39.695 accidents with personal injuries in the year 1997, had a registered crash circumstance „skidding" or „sliding" → especially with wet road condition
- To get rid of the skidding danger and to do something for the road safety, vehicle tyre manufacturer optimized the grip of their tyre products continuously → on the

other side the friction quality of road pavement in Austria has not been improved actively

- The correlation between accident risk and the quality of the road surface shows a long-term testing of the Bavarian motorway network → it has been verified, that the accident risk on wet roads with a low friction is 35% higher than on road sections with sufficient skid resistance → roads with low friction values have a significant high ratio of accidents under wet conditions
- Also in Austria: Data analysis from the Austrian Road Safety Board on the B 312 (about 6km asphalt with lime stones, on another 6.3km diabase) → on the lime stone section 54% more accidents under wet condition happen than on the road section with diabase (in an observation time of 2 years) → this result is more interesting, when you check the trace geometry – the lime stone section seems more safety (low number of cross sections, a few curves)
- It was proven, that an increase of the skid resistance leads to an increase in road safety

"Untersuchungen über die Verkehrssicherheit bei Nässe; (Griffigkeitsmessungen bei hohen Geschwindigkeiten)", Schulze K.-H., Dames J., Lange H., Forschung Straßenbau und Straßenverkehrstechnik, Heft 189, Bonn, 1975

„Analysis of the traffic safety under wet conditions; (Skid resistance measures at high speeds)"

Conclusions of the first part of article:

The correlation between friction values of the road surface and accidents has been analysed the first time in the year 1963. The influence of low friction was significant only at wet conditions. The skid resistance measurements of dry road surfaces always show high values between 0.65 and 0.95.

Different examples of statistical methods prove these very early statements. Specific key points are the analysis regarding road geometry (curve radii, critical areas for the drainage. etc.).

Case studies on a macroscopic and microscopic level on German roads demonstrate the methodology and the problems of investigations.

Skid resistance values under 0.26 are connected with extremely high accident risk on wet roads. Values over 0.35 show a "normal" ratio of wet-accidents.

"Untersuchungen des ursächlichen Zusammenhangs zwischen Unfallgeschehen und Griffigkeit", Hiersche E.-U., Tenzinger B., Forschung Straßenbau und Straßenverkehrstechnik, Heft 587, Bonn, 1990

„Analysis of a causal relationship between accidents and skid resistance"

Abstract:

"The original objective of the research project was to investigate the existence of a causal, particularly quantitative, relationship between accidents and skid resistance. For many reasons, particularly due to the small sample size, this objective proved unattainable. It was therefore necessary to make extensive changes to the project's main areas of focus.

The basic material for the investigation is provided by a collection of accident data on more than 10.000 accidents and the relevant traffic accident files. Although the vast majority of the accident data is quantitative data, due to the great number of recorded accident characteristics, they nevertheless provide detailed descriptions of individual accidents.

The study's focus is the analysis of relationship structures within the complex circumstances of an accident. This entails using statistical methods, namely log linear models, which have hitherto been neglected in accident research. This permits a multivariate, that is, simultaneous, analysis of qualitative accident data. Particular attention is devoted to the role played by the road surface, but sight is not lost of the fact that it constitutes only one component of several in the circumstances of the accident as a whole. Any actual "causes" accident responsibility is also evaluated, particularly in respect of the prevailing road surface conditions. As a result, this study, while providing confirmation of results and relationships already established, at the same time provides some new information and affords greater insight into the complex relationships of the circumstances of road traffic accidents.

A depiction of the very large number of important relationships far exceeds the remit of an abridged report. This report only identifies the most important dominant relationship structures and influencing factors."

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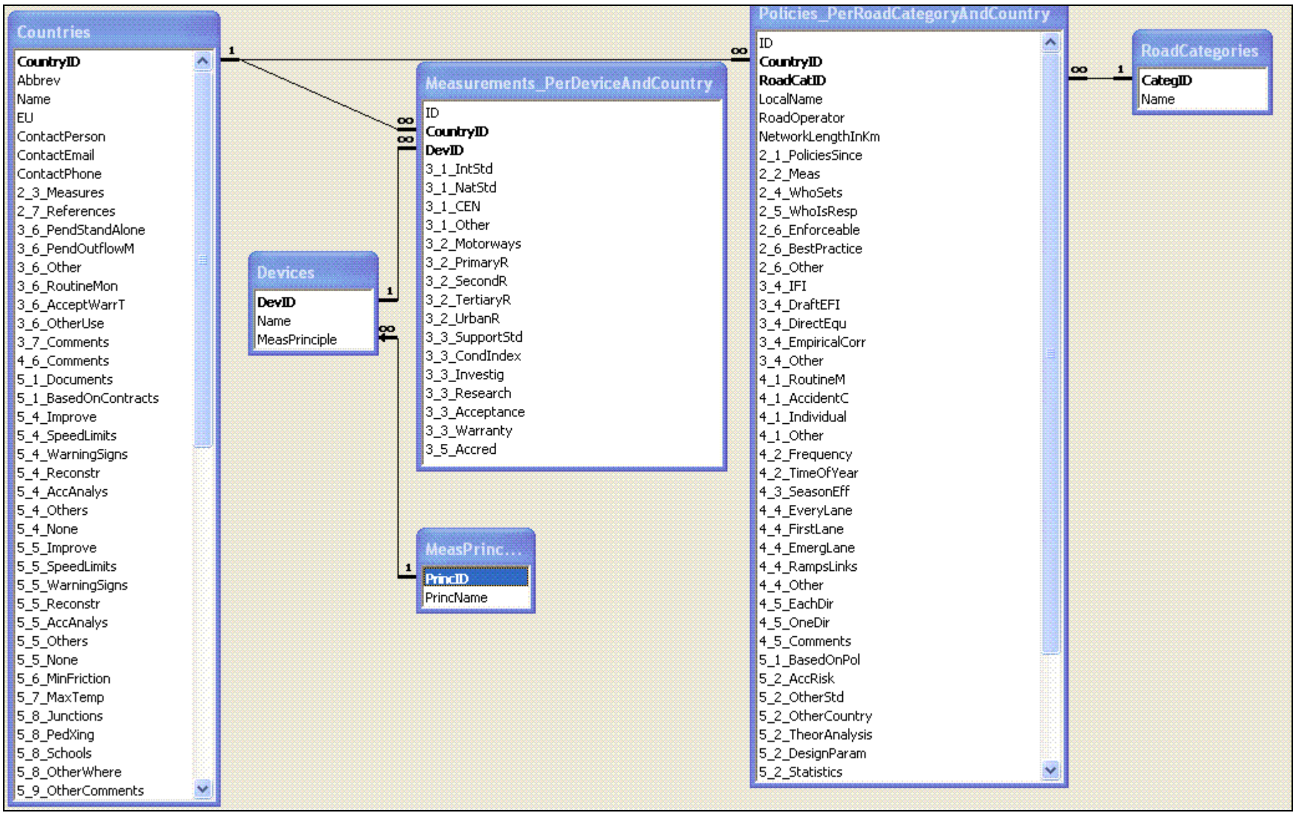
Annex II: List of documents and standards concerning skid resistance

The following table consists of references on standards and regulations as they were mentioned in the questionnaire concerning skid resistance standards.

Country	National standards	International standards
AT	RVS 11.06.65 RVS 11.06.71 ON B3591, order of Ministry of transport RVS 13.01.15 RVS 08.17.02 RVS 08.16.01	EN 13036-4:2003 CEN TS RoadSTAR
BE	Standaardbestek 250 (contractual document)	
BG		EN 130 36-1 EN 130 36-2 EN 130 36-4
CZ	ČSN 73 6177	CEN/TC 227/WG 5 N 191 E Rev.1: TRT technical specification
DE	ZTV ZEB-StB	
DK	Danish Road Standards Maintenance: Konstruktion og vedligeholdelse af veje og stier Hæfte 4; Construction: Varmt blandet asfalt, Almindelige arbejdsbeskrivelse	
ES	NLT-336 which is based on the TRRL Laboratory Report 737 "Measurement of skidding resistance. Part I. Guide to the use of SCRIM" (1976)	UNE EN 3036-1 UNE EN 1097-8
FR	NF P 98 220-1 measurement of skid resistance with a low speed friction device NF P 98-220-2 Method to obtain a longitudinal friction coefficient; NF 0 98_220-3 Method to obtain a sideway force friction coefficient (SFC)	EN 13036-1 Measurement of pavement surface macrotexture depth using a volumetric patch technique EN ISO 13473-1: Measurements of pavement surface macrotexture depth using profilometric measurements EN 13036-4: Measurement of a friction coefficient with the Pendulum
HU	VT 2-2. 111 technical directives	
LV	Autoceļu specifikācijas 2005 (http://www.lvceli.lv/LV/?i=107&DirID=42) LVS EN 13036-2	
NL	Richtlijnen voor het onderhoud van Rijkswegen, Ministry of Transport, Public Works and Water Management, Den Haag (Su), 1983, Ministeriele nota piece number 17600 B CROW "Standaard RAW bepalingen 2005" Proef 150 (Standard specifications for contracts, test methods 150) CROW publication 20A/B/C “Rational Pavement Management” 1987	CEN TS The RWS-NL skid resistance trailer

Country	National standards	International standards
PL	Dz.U.99.43.430, order of Minister of transport Dz.U.02.12.116, order of Minister of transport SOSN, order of Director of GDDKiA	
SE	VVMB 104 - Bestämning av friktion på belagd yta, Vägverket 1990:117 ATB VÄG 2005 VV Publication 2005:112 ATB Vinter 2003. VV Publication 2002:148	SS-EN 1436:1997 (Road marking materials, Road marking performance for road users)
SI	Technical Specification for roads TSC 06.620: Road Pavement characteristics Skid resistance; Ministry of transport, Slovenian Road Agency, 2003.	
SK	TP 14/2006, order Ministry of Transport, Post and Telecommunications STN 736177 STN736195	EN STN 13036-4
UK	Design Manual for Roads and Bridges, Volume 7, HD28/04. Interim Advice Note IAN98 - the standard and supporting advice for Motorways and Trunk Roads; Local Authorities Association Code of Good Practice - provides general guidance Many documents written by individual local authorities	

Annex III: Tables and connections of the skid resistance database to analyse the questionnaire results



Annex IV: Completed questionnaires

On the following pages, all completed questionnaires are enclosed.

17 EU countries have answered the questionnaire on skid resistance. The forms are ordered alphabetically:

Austria
Belgium (Flanders)
Bulgaria
Czech Republic
Denmark
France
Germany
Hungary
Ireland
Latvia
Netherlands
Poland
Slovakia
Slovenia
Spain
Sweden
United Kingdom

15 EU countries have answered the questionnaire on skid resistance. The forms are ordered alphabetically:

Austria
Belgium
Bulgaria
Czech Republic
France
Germany
Latvia
Netherlands
Poland
Portugal
Slovakia
Slovenia
Sweden
United Kingdom

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Austria
Your organisation:	arsenal research
Contact details *(e.g. Email, phone number,…)*:	Peter Maurer, peter.maurer@arsenal.ac.at

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES			
Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire. *Please fill in the local name of each road class, the name of the road operator and the approximate road network length.*			
Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Autobahnen und Schnellstraßen, ASFINAG-Netz		
Road operator(s):	ASFINAG	Network length:	2.112
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Landesstraßen B		
Road operator(s):	Federal states	Network length:	9.996
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Landesstraßen L		
Road operator(s):	Federal states	Network length:	23.687
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Gemeindestraßen		
Road operator(s):	Municipalities	Network length:	71.059
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Stadtstraßen		
Road operator(s):	Municipalities	Network length:	unknown

SECTION 2. OVERVIEW OF POLICY MANAGEMENT					
2.1 Do road administrations set policies or standards for skid resistance in your country?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	☒ since 2004	☐ since	☐ since	☐ since	☐ since
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	☒ since 1980s	☒ since 2001	☒ since 2004	☐ since	☐ since
2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	material specification (PSV)				
2.4 Who sets the policy or policies or standards your country?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	Ministry of transport, Austrian road research federation	in discussion with federal states	in discussion with federal states		
2.5 Who is responsible for administering the standards and monitoring them?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	Ministry of transport, Austrian road research federation				

2.6 What is the legal status of the standards in your country?		Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	Legally enforce-able	☒	☐	☐	☐	☐
	Represent best practice	☐	☒	☒	☐	☐
	Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	RVS 11.06.65, RVS 11.06.71, EN 13036-4:2003 ON B3591, order of Ministry of transport RVS 13.01.15, RVS 08.17.02, RVS 08.16.01 CEN TS RoadSTAR

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names	Devices are based on:			
(Please fill in the names of the devices used)	International standard	National standard	CEN technical specification	Other standard
Device 1: Pendulum test	☒	☐	☐	
Device 2: RoadSTAR	☐	☒	☒	RVS 11.06.65
Device 3: Griptester	☐	☐	☐	RVS 11.06.71
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒	☐	☐	☐
Primary roads	☒	☒	☐	☐	☐
Secondary roads	☒	☒	☐	☐	☐
Tertiary roads	☒	☒	☐	☐	☐
Urban roads	☒	☒	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☒	☐	☐	☐
Part of a condition index	☐	☒	☐	☐	☐
Local investigations	☒	☒	☐	☐	☐
Research tool	☐	☒	☒	☐	☐
Acceptance tests	☒	☒	☐	☐	☐
Warranty tests	☒	☒	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	no harmonisation known
Primary roads		☐	☐	☐	☐	no harmonisation known
Secondary roads		☐	☐	☐	☐	no harmonisation known
Tertiary roads		☐	☐	☐	☐	no harmonisation known
Urban roads		☐	☐	☐	☐	no harmonisation known

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	calibration needed
Device 2	quality management system and calibration routines defined in national standard ON B3591
Device 3	none defined yet
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?	☐ As a stand-alone measurement ☒ Only in combination with an outflow meter ☐ Others: (Leave it empty, if you do not use the pendulum test)
	☐ For routine monitoring or Pavement Management ☒ For acceptance or warranty tests ☐ Others: acceptance/warranty test only on sections <500 m length allowed; for longer sections RoadSTAR measurment needed (Leave it empty, if you do not use the pendulum test)
3.7 Use this space to give any other comments about measurement devices:	

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☒	☐	☐
Accident cluster analysis	☒	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☒	☒	☐	☐	☐
Other	acceptance/ warranty tests				

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	every 5th year	every 5th year	every 5th year	none	none
Time of year	April-Oct	April-Oct	April-Oct		

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	none
Primary roads	none
Secondary roads	none
Tertiary roads	none
Urban roads	none

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

4.4 Where are the systematic skid resistance measurements usually taken on motorways?	☐ On every lane ☒ On the first lane only ☐ On the emergency lane ☒ On ramps or link roads ☐ Other where: in future: every lane		☒ in each direction ☐ only in one direction	
4.5 Where are the systematic skid resistance measurements taken on non-motorways?		In each direction	Only in one direction	Comments
	Primary roads	☐	☒	
	Secondary roads	☐	☒	
	Tertiary roads	☐	☐	
	Urban roads	☐	☐	
	(Please mark a cross for each road class to specify where it is measured)			
4.6 Are there any other points about monitoring practice not covered here?				

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:* RVS 08.17.02, RVS 08.16.01	☒ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☒ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☒	☒	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☒	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☒	☐	☐	☐	☐
Other		based on motorway levels	based on motorway levels		

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	very good	good	average	poor	very poor			
Motorways	μ > 0,75	0,75 >= μ > 0,59	0,59 >= μ > 0,45	0,45 >= μ > 0,38	μ <= 0,38			
Primary roads	μ > 0,75	0,75 >= μ > 0,59	0,59 >= μ > 0,45	0,45 >= μ > 0,38	μ <= 0,38			
Secondary roads	μ > 0,75	0,75 >= μ > 0,59	0,59 >= μ > 0,45	0,45 >= μ > 0,38	μ <= 0,38			
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: thresholds on primary and secondary roads are in practical use, but not defined in policies	
5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☒ Accident analysis ☒ Other measures *(please fill in)*: special attention on section ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☒ Reconstruction of the road ☒ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is 5 - 50°C (surface temp.) / -°C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

<table>
<tr><th colspan="3">SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">6.1 Are acceptance tests required for newly built roads?</td><td>☒ Yes, …</td><td>☒ On motorways, since (please fill in a year date): 2004
☐ On primary roads, since (please fill in a year date):
☐ On secondary roads, since (please fill in a year date):
☐ On tertiary roads, since (please fill in a year date):
☐ On urban roads, since (please fill in a year date):</td></tr>
<tr><td colspan="2">☐ No
(If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">6.2 Where are your acceptance tests based on?</td><td>☒ Policies, regulations or standards…

please specify name / number of document:
RVS 08.16.01, RVS 08.17.02</td><td>☒ For motorways
☐ For primary roads
☐ For secondary roads
☐ For tertiary roads
☐ For urban roads</td></tr>
<tr><td>☒ Building plans/contracts…</td><td>(Use this space to comment))</td></tr>
<tr><td>6.3 When have the acceptance tests to be taken?</td><td colspan="2">☐ Before road opening
☒ After road opening (please fill in a time span): up to 12 weeks after opening</td></tr>
<tr><td>6.4 How many runs are taken for an acceptance test measurement?</td><td colspan="2">☒ One measurement per acceptance test
☐ Two measurements per acceptance test
☐ More (please comment): additional run if values of first run below limit</td></tr>
<tr><td>6.5 Which measures are taken until the acceptance limits are verified?</td><td colspan="2">☐ Speed limits
☐ Warning signs
☒ Other measures (please fill in):
☒ None</td></tr>
<tr><td>6.6 What values have to be reached in the acceptance tests?</td><td colspan="2">On motorways: μ = 0.62 less measurement tolerance 0.03
On primary roads: μ = -
On secondary roads: μ = -
On tertiary roads: μ = -
On urban roads: μ = -

(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
</table>

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☒ Money deduction (as long as μ ≥ 0.53) ☒ Speed limits ☒ Warning signs ☒ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☒ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE			
7.1 Are warranty tests required to check the skid resistance of roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 2004 ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:	
	☐ No *(If no, please proceed to the next section)*		
7.2 Where are your warranty tests based on?	☒ Policies, regulations or standards *please specify name / number of document:* RVS 08.16.01, RVS 08.17.02	☒ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads	
	☒ Building plans/contracts	*(Use this space to comment))*	
7.3 How long is the warranty period?	3 - 5, usually 5 years *(Please fill in a time span, e.g. 5 years)*		
7.4 How many runs are taken for a warranty test measurement?	☒ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*: additional run if values of first run below limit		
7.5 What values have to be reached in the warranty tests?	On motorways: μ = 0.52 On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*		
7.6 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☒ Reconstruction of the road ☒ Other measures *(please fill in)*: extension of warranty period for 2 years ☐ None		
7.7 Any other comments regarding warranty test measurements:	If traffic calming measures are necessary, a penalty is imposed.		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

TYROSAFE
Task 1.1

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Belgium (Flanders)
Your organisation:	Roads and Traffic Agency
Contact details *(e.g. Email, phone number,…)*:	margo.briessinck@mow.vlaanderen.be +32 2-727 09 25

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES			
Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire. *Please fill in the local name of each road class, the name of the road operator and the approximate road network length.*			
Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Hoofdwegen		
Road operator(s):	Flemish government	Network length:	900 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Primaire wegen		
Road operator(s):	Flemish government	Network length:	
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Secundaire wegen		
Road operator(s):	Flemish government	Network length:	5000 (prim + sec)
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Lokale wegen		
Road operator(s):	Local government (municipalities)	Network length:	
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Lokale wegen		
Road operator(s):	Local government (municipalities)	Network length:	

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.1 Do road administrations set policies or standards for skid resistance in your country?	☒ since	☒ since	☒ since	☒ since	☒ since

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	☒ since	☒ since	☒ since	☐ since	☐ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	PSV of aggregates

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.4 Who sets the policy or policies or standards your country?	Fl. gov	Fl. gov	Fl. gov		

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.5 Who is responsible for administering the standards and monitoring them?	Fl. gov	Fl. gov	Fl. gov		

2.6 What is the legal status of the standards in your country?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Legally enforce-able	☐	☐	☐	☐	☐
Represent best practice	☐	☐	☐	☐	☐
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	Standaardbestek 250 (contractual document)

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names	Devices are based on:			
(Please fill in the names of the devices used)	International standard	National standard	CEN technical specification	Other standard
Device 1: SCRIM	☐	☒	☐	
Device 2: Griptester	☐	☒	☐	
Device 3: Pendulum	☐	☐	☒	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☐	☐	☐	☐
Primary roads	☒	☐	☐	☐	☐
Secondary roads	☒	☒	☒	☐	☐
Tertiary roads	☐	☐	☐	☐	☐
Urban roads	☐	☐	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☒	☐	☐	☐	☐
Part of a condition index	☒	☐	☐	☐	☐
Local investigations	☒	☒	☒	☐	☐
Research tool	☒	☒	☐	☐	☐
Acceptance tests	☒	☐	☒	☐	☐
Warranty tests	☒	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways	SCRIM	☐	☐	☐	☐	
Primary roads	SCRIM	☐	☐	☐	☐	
Secondary roads	SCRIM	☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	calibration by manufacturer (every two years)
Device 2	
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?	☒ As a stand-alone measurement ☐ Only in combination with an outflow meter ☐ Others: (Leave it empty, if you do not use the pendulum test)
	☐ For routine monitoring or Pavement Management ☒ For acceptance or warranty tests ☐ Others: (Leave it empty, if you do not use the pendulum test)
3.7 Use this space to give any other comments about measurement devices:	

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☐	☐	☐
Accident cluster analysis	☐	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☐	☐	☐	☐	☐
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	annually	every 2nd year	every 2nd year		
Time of year					

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	
Primary roads	
Secondary roads	
Tertiary roads	
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

4.4 Where are the systematic skid resistance measurements usually taken on motorways?	☐ On every lane ☒ On the first lane only ☐ On the emergency lane ☐ On ramps or link roads ☐ Other where:	☒ in each direction ☐ only in one direction

		In each direction	Only in one direction	Comments
4.5 Where are the systematic skid resistance measurements taken on non-motorways?	Primary roads	☒	☐	
	Secondary roads	☒	☐	
	Tertiary roads	☐	☐	
	Urban roads	☐	☐	
	(Please mark a cross for each road class to specify where it is measured)			
4.6 Are there any other points about monitoring practice not covered here?				

SECTION 5. THRESHOLDS AND STANDARDS		
5.1 Where are your thresholds based on?	☐ Policies, regulations or standards… *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☒ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	very good	good	acceptable	bad	very bad			
Motorways	> 0.70	> 0.55	> 0.40	> 0.25	< 0.25			
Primary roads	id.							
Secondary roads	id.							
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments:

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is °C (surface temp.) / 5°C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: ☒ On primary roads, since *(please fill in a year date)*: ☒ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☒ Policies, regulations or standards… *please specify name / number of document:* Standaardbestek 250	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☐ Before road opening ☒ After road opening *(please fill in a time span)*:	
6.4 How many runs are taken for an acceptance test measurement?	☒ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☒ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = .48 On primary roads: μ = .48 On secondary roads: μ = .48 On tertiary roads: μ = .48 On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☒ Money deduction (as long as μ ≥ .43) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☒ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 2006 ☒ On primary roads, since *(please fill in a year date)*: 2006 ☒ On secondary roads, since *(please fill in a year date)*: 2006 ☒ On tertiary roads, since *(please fill in a year date)*: 2006 ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☒ Policies, regulations or standards *please specify name / number of document:* Standaardbestek 250	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	3 years *(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☒ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = .48 On primary roads: μ = .48 On secondary roads: μ = .48 On tertiary roads: μ = .48 On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☒ Money deduction (as long as μ >= .43) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Bulgaria
Your organisation:	National Road Infrastructure Agency - Central Roads and Bridges Laboratory
Contact details *(e.g. Email, phone number,…)*:	crbl@ttm.bg, crbl@abv.bg, tel. +359 2 945 03 50, fax. +359 2 945 06 83

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	"Avtomagistrali" (Автомагистрали)		
Road operator(s):	National Road Infrastructure Agency (NRIA)	Network length:	328 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	"First class roads"(Първокласни пътища)		
Road operator(s):	NRIA	Network length:	3021 km
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	"Second class roads"(Второкласни пътища)		
Road operator(s):	NRIA	Network length:	4011 km
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	"Third class roads"(Третокласни пътища)		
Road operator(s):	NRIA	Network length:	11719 km
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	"Municipality(local) roads"(Общински (местни) пътища)		
Road operator(s):	Municipalities and Ministry of regional development and public works	Network length:	≈ 21000 km

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.1 Do road administrations set policies or standards for skid resistance in your country?	☒ since	☒ since	☒ since	☒ since	☐ since
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	☒ since	☒ since	☒ since	☒ since	☐ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?

Yes. There are requirements for aggregate abrasion and Acceleration polishing index (second must be over 50 for wearing courses)

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.4 Who sets the policy or policies or standards your country?	NRIA	NRIA	NRIA	NRIA	Ministry of regional development and public works (MRDPW)
2.5 Who is responsible for administering the standards and monitoring them?	NRIA	NRIA	NRIA	NRIA	MRDPW, Municipalities

2.6 What is the legal status of the standards in your country?

* If they are included in respective technical specification or regulation.

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Legally enforce-able	☒*	☒*	☒*	☒*	☐
Represent best practice	☐	☐	☐	☐	☒*
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:

EN 130 36-1

EN 130 36-2

EN 130 36-4

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: Skid resistance tester (pendulum)	☐	☐	☒	
Device 2: Friction measurement equipment*	☐	☐	☒	
Device 3:	☐	☐	☐	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

** There is a bidding procedure of the World Bank for delivery of Friction measurement equipment. At the moment it is not available in the country.*
(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒*	☐	☐	☐
Primary roads	☒	☒*	☐	☐	☐
Secondary roads	☒	☒*	☐	☐	☐
Tertiary roads	☒	☒*	☐	☐	☐
Urban roads	☐	☐	☐	☐	☐

* Intended to be used
Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☐	☐	☐	☐
Part of a condition index	☒	☐	☐	☐	☐
Local investigations	☐	☐	☐	☐	☐
Research tool	☐	☐	☐	☐	☐
Acceptance tests	☒*	☐	☐	☐	☐

Warranty tests	☐	☐	☐	☐	☐
** At the moment only acceptance tests for Black spots and road sections with high number of accidents. (Please tick the boxes as appropriate.)*					

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Metrological control and callibration from accredited national laboratories
Device 2	Metrological control and callibration from accredited national laboratories
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?	☒ As a stand-alone measurement ☐ Only in combination with an outflow meter ☒ Others: Together with Volumetric test according to EN 130 36-4 (Leave it empty, if you do not use the pendulum test)
	☐ For routine monitoring or Pavement Management ☒ For acceptance or warranty tests ☒Others: Black spots (Leave it empty, if you do not use the pendulum test)
3.7 Use this space to give any other comments about measurement devices:	

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☐	☐	☐	☐	☐
Accident cluster analysis	☒	☒	☒	☒	☐
Response to individual crashes, e.g. police request	☒	☒	☒	☒	☐
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	No	No	No	No	No
Time of year	No	No	No	No	No

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	No
Primary roads	No
Secondary roads	No
Tertiary roads	No
Urban roads	No

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

4.4 Where are the systematic skid resistance measurements usually taken on motorways?	☒On every lane ☐ On the first lane only ☐ On the emergency lane ☐ On ramps or link roads ☐ Other where:	☒ in each direction ☐ only in one direction

		In each direction	Only in one direction	Comments
4.5 Where are the systematic skid resistance measurements taken on non-motorways?	Primary roads	☒	☐	
	Secondary roads	☒	☐	
	Tertiary roads	☒	☐	
	Urban roads	☐	☐	No data available(NDA)
	(Please mark a cross for each road class to specify where it is measured)			
4.6 Are there any other points about monitoring practice not covered here?	No			

SECTION 5. THRESHOLDS AND STANDARDS		
5.1 Where are your thresholds based on?	☒Policies, regulations or standards… *please specify name / number of document:*	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☒	☒	☒	☒	☐
Based on statistics (e.g. cumulative frequencies)	☒	☒	☒	☒	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	good	poor						
Motorways	SRT ≥45	SRT < 45						
Primary roads	SRT ≥45	SRT < 45						
Secondary roads	SRT ≥45	SRT < 45						
Tertiary roads	SRT ≥45	SRT < 45						
Urban roads	NDA	SRT < 45						

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: At the moment we use only SRT values from pendulum test.

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☒ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☒ Reconstruction of the road ☒ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is 35°C (surface temp.) / 35°C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☒ Other where: No data available *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

<table>
<tr><th colspan="3">SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">6.1 Are acceptance tests required for newly built roads?</td><td>☐ Yes, …</td><td>☐ On motorways, since (please fill in a year date):
☐ On primary roads, since (please fill in a year date):
☐ On secondary roads, since (please fill in a year date):
☐ On tertiary roads, since (please fill in a year date):
☐ On urban roads, since (please fill in a year date):</td></tr>
<tr><td colspan="2">☒No
(If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">6.2 Where are your acceptance tests based on?</td><td>☒ Policies, regulations or standards…
please specify name / number of document:</td><td>☒ For motorways
☒ For primary roads
☒For secondary roads
☒ For tertiary roads
☐ For urban roads</td></tr>
<tr><td>☐ Building plans/contracts…</td><td>(Use this space to comment))</td></tr>
<tr><td>6.3 When have the acceptance tests to be taken?</td><td colspan="2">☐ Before road opening
☒After road opening (please fill in a time span): In case of presence of data for black spots or road sections with high number of accidents</td></tr>
<tr><td>6.4 How many runs are taken for an acceptance test measurement?</td><td colspan="2">☐ One measurement per acceptance test
☐ Two measurements per acceptance test
☒More (please comment): five</td></tr>
<tr><td>6.5 Which measures are taken until the acceptance limits are verified?</td><td colspan="2">☐ Speed limits
☒ Warning signs
☐ Other measures (please fill in):
☐ None</td></tr>
<tr><td>6.6 What values have to be reached in the acceptance tests?</td><td colspan="2">On motorways: μ =
On primary roads: μ =
On secondary roads: μ =
On tertiary roads: μ =
On urban roads: μ =

SRT ≥ 45
(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
</table>

6.7 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☒None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☐ Policies, regulations or standards *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	*(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Czech Republic
Your organisation:	CDV - Transport Research Centre
Contact details *(e.g. Email, phone number,…)*:	josef.stryk@cdv.cz

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

<table>
<tr><td>Motorways</td><td colspan="3">High capacity roads designed to carry fast motor traffic safely
Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway
Access is typically grade-separated and junctions are free-flowing
Some categories of users (pedestrians, cyclists, tractors, …) are not permitted
In many countries, a toll has to be paid for usage</td></tr>
<tr><td>Local name in your country:</td><td colspan="3">dálnice (motorway), rychlostní silnice (high spped roads - another category but very simillar to motorway with some small differences e.g. smaller diameter of curves)</td></tr>
<tr><td>Road operator(s):</td><td>Road and motorway directorate of the Czech Republic</td><td>Network length:</td><td>633 km + 329 km</td></tr>
<tr><td>Primary roads</td><td colspan="3">Major roads linking important local centres
Provide access to motorways
Available to all types of traffic
Typically single carriageway but may have sections of dual carriageway
Can have traffic lights
Usually a distinct numbering system for the whole country is used</td></tr>
<tr><td>Local name in your country:</td><td colspan="3">silnice I. třídy (first class roads) - normaly includes high speed roads, but in mentioned number they are not included</td></tr>
<tr><td>Road operator(s):</td><td>Road and motorway directorate of the Czech Republic</td><td>Network length:</td><td>5.843 km</td></tr>
<tr><td>Secondary roads</td><td colspan="3">Roads linking smaller local centres
Usually single carriageway but may have local dual carriageway sections
Provide access to primary roads
No access restrictions
Local numbering system usually not shown along the road</td></tr>
<tr><td>Local name in your country:</td><td colspan="3">silnice II. třídy (second class roads)</td></tr>
<tr><td>Road operator(s):</td><td>14 state districts</td><td>Network length:</td><td>14.660 km</td></tr>
<tr><td>Tertiary or minor roads</td><td colspan="3">Roads providing local networks or links between smaller towns and villages, typically in rural areas
Not usually in national classification or numbering system
May be single-track in remote areas</td></tr>
<tr><td>Local name in your country:</td><td colspan="3">silnice III. třídy (second class roads)</td></tr>
<tr><td>Road operator(s):</td><td>14 state districts</td><td>Network length:</td><td>34.118 km</td></tr>
<tr><td>Urban roads / Residential roads</td><td colspan="3">Roads in urban areas
Typically subject to a speed limit of 50 km/h (or equivalent) or less</td></tr>
</table>

Local name in your country:	místní a účelové komunikace (local and purpose roads)		
Road operator(s):	cities	Network length:	- situation to 1.1.2007 in all cases

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

2.1 Do road administrations set policies or standards for skid resistance in your country?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
☒ since	☒ since	☒ since	☒ since	☒ since

2.2 Even if they do not have a formal policy, do they make skid resistance measurements?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
☒ since	☒ since	☒ since	☒ since	☒ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?

microtexture (pendulum) and macrotexture measurements (sand patch, ARAN, ARGUS), polish stone value

2.4 Who sets the policy or policies or standards in your country?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Ministry of transport with cooperation of Road and motorway directorate and other expert groups	Ministry of transport	Ministry of transport	Ministry of transport	Ministry of transport

2.5 Who is responsible for administering the standards and monitoring them?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
operator = Road and motorway directorate	Road and motorway directorate	state district authorities	state district authorities	cities

2.6 What is the legal status of the standards in your country?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Legally enforce-able	☒	☒	☒	☒	☒
Represent best practice	☐	☐	☐	☐	☐
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance

ČSN 73 6177

CEN/TC 227/WG 5 N 191 E Rev.1: TRT technical specification

policies:	

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: TRT	☐	☒	☒	
Device 2: Griptester	☒	☐	☐	Guidebook is prepared to allow international devices measure according to national standard
Device 3: SCRIM	☒	☐	☐	Guidebook is prepared to allow international devices measure according to national standard
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒	☒	☐	☐
Primary roads	☒	☒	☒	☐	☐
Secondary roads	☒	☒	☒	☐	☐
Tertiary roads	☒	☒	☒	☐	☐
Urban roads	☒	☒	☒	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☐	☐	☐	☐
Part of a condition index	☒	☐	☐	☐	☐
Local investigations	☒	☒	☒	☐	☐
Research tool	☒	☒	☒	☐	☐

Acceptance tests	☒	☒	☒	☐	☐
Warranty tests	☒	☒	☒	☐	☐
(Please tick the boxes as appropriate.)					

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways	TRT, GripTester, SCRIM	☐	☒	☒	☐	
Primary roads	TRT, GripTester, SCRIM	☐	☐	☒	☐	
Secondary roads	TRT, GripTester, SCRIM	☐	☐	☒	☐	
Tertiary roads	TRT, GripTester, SCRIM	☐	☐	☒	☐	
Urban roads	TRT, GripTester, SCRIM	☐	☐	☒	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	
Device 2	correlation with TRT must fit requirements which are set in Guidbook for comparative measurements
Device 3	correlation with TRT must fit requirements which are set in Guidbook for comparative measurements
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?

☒ As a stand-alone measurement
☐ Only in combination with an outflow meter
☐ Others:
(Leave it empty, if you do not use the pendulum test)

☐ For routine monitoring or Pavement Management
☐ For acceptance or warranty tests
☒ Others: Only as suplementary measurement
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:

TRT is national measurement device for skid resistance measurements. All other devices must be correlate with it before their usage on national roads. If correlation is not good, device can not be used in the Czech Rep.

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☒	☐	☐
Accident cluster analysis	☒	☒	☒	☒	☒
Response to individual crashes, e.g. police request	☒	☒	☒	☒	☒
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	annually (two years frequency is in plan)	annually (two years frequency is in plan)			
Time of year					

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	
Primary roads	
Secondary roads	
Tertiary roads	
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☐ On every lane
☒ On the first lane only
☐ On the emergency lane
☒ On ramps or link roads
☐ Other where:</td><td colspan="2">☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4">for newly build roads - in both directions</td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:*	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☒	☒	☒	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☒	☒	☒	☒	☒
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	Very good	Good	Fair	Poor	Very poor			
Motorways	≥ 0.51	0.50-0.47	0.46-0.37	0.36-0.29	≤ 0.28			
Primary roads	≥ 0.51	0.50-0.47	0.46-0.37	0.36-0.29	≤ 0.28			
Secondary roads	≥ 0.47	0.46-0.42	0.41-0.34	0.33-0.26	≤ 0.25			
Tertiary roads	≥ 0.47	0.46-0.42	0.41-0.34	0.33-0.26	≤ 0.25			
Urban roads	≥ 0.47	0.46-0.42	0.41-0.34	0.33-0.26	≤ 0.25			

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: Above mentioned are levels for TRT parameter fp (longitudinal friction coefficient) according to current standard CSN 736177 (1996) which is currently under revision; there are two categories of pavements for evaluation: A (motorway, high speed roads, first clasds roads) and B (other roads of lower class). Measurement is realized with different speeds (40, 60, 80, 100 and 120 km/h), there are tresholds for each speed. The above mentioned numbers correspond to speed 80 km/h, slip ratio 25%.

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☒ Speed limits ☐ Warning signs ☒ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is 50°C (surface temp.) / °C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☒ At junctions: μ = depends on measuring speed ☒ Before pedestrian crossings: μ = depends on measuring speed ☐ At schools, kindergartens, etc.: μ = ☒ Other where: grade crossing *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	We have two groups of roads 1. With normal skid resistance requirements, 2. With high skid resistance requirements (crosings, roundabouts, pedestrial crossings etc.). If the measurement is done in different speeds (eg. 60, 80, 100) then conclusive speed is 60 km/h. Roads can be measured by these speeds: 40, 60, 80, 100, 120 km/h.

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: ☒ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☒ Policies, regulations or standards… *please specify name / number of document:*	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☐ Before road opening ☒ After road opening *(please fill in a time span)*: Before one month after opening, it is new requirement in revision of national standard	
6.4 How many runs are taken for an acceptance test measurement?	☐ One measurement per acceptance test ☐ Two measurements per acceptance test ☒ More *(please comment)*: for at least three speeds	
6.5 Which measures are taken until the acceptance limits are verified?	☒ Speed limits ☒ Warning signs ☐ Other measures *(please fill in)*: ☐ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = depends on measuring speed On primary roads: μ = depends on measuring speed On secondary roads: μ = depends on measuring speed On tertiary roads: μ = depends on measuring speed On urban roads: μ = depends on measuring speed *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☐ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: ☒ On primary roads, since *(please fill in a year date)*: ☒ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☒ Policies, regulations or standards *please specify name / number of document:*	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	5 years for concrete and 4 years for asphalt pavements, can be also 7-10 years *(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☒ More *(please comment)*: at least three runs with different speed	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = depends on measuring speed On primary roads: μ = depends on measuring speed On secondary roads: μ = depends on measuring speed On tertiary roads: μ = depends on measuring speed On urban roads: μ = depends on measuring speed *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Denmark
Your organisation:	Danish Road Directorate, Danish Road INstitute
Contact details *(e.g. Email, phone number,…)*:	Bjarne Schmidt; BJS@VD.DK, tel:+4572447140

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Motorveje		
Road operator(s):	Danish Road Directorate	Network length:	1022
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Øvrige statsveje		
Road operator(s):	Dansih Road Directorate	Network length:	2766
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Trafikveje		
Road operator(s):	Municipality	Network length:	32369
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Lokalveje, land		
Road operator(s):	Municipalities	Network length:	21335
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Lokalveje, by		
Road operator(s):	Municipalities	Network length:	14893

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

2.1 Do road administrations set policies or standards for skid resistance in your country?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
☒ since 1965	☒ since 1965	☒ since 1965	☒ since 1965	☒ since 1965

2.2 Even if they do not have a formal policy, do they make skid resistance measurements?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
☒ since 1952	☒ since 1952	☒ since 1952	☒ since 1952	☒ since 1952

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?

2.4 Who sets the policy or policies or standards your country?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Danish Road standards Board	Danish Road standards Board	Danish Road standards Board	Danish Road standards Board	Danish Road standards Board

2.5 Who is responsible for administering the standards and monitoring them?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Road Directorate	Road Directorate	Municipality	Municipality	Municipality

2.6 What is the legal status of the standards in your country?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Legally enforce-able	☒	☒	☒	☒	☒
Represent best practice	☐	☐	☐	☐	☐
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:

Danish Road Standards

Maintenance: Konstruktion og vedligeholdelse af veje og stier Hæfte 4

Construction: Varmt blandet asfalt, Almindelige arbejdsbeskrivelse

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: ROAR	☐	☒	☒	
Device 2:	☐	☐	☐	
Device 3:	☐	☐	☐	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☐	☐	☐	☐
Primary roads	☒	☐	☐	☐	☐
Secondary roads	☒	☐	☐	☐	☐
Tertiary roads	☒	☐	☐	☐	☐
Urban roads	☒	☐	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☒	☐	☐	☐	☐
Part of a condition index	☐	☐	☐	☐	☐
Local investigations	☒	☐	☐	☐	☐
Research tool	☒	☐	☐	☐	☐
Acceptance tests	☒	☐	☐	☐	☐
Warranty tests	☒	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Annual calibration test on specific section on in-service roads, calibration of hydraulic parts
Device 2	
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?	☒ As a stand-alone measurement ☐ Only in combination with an outflow meter ☐ Others: (Leave it empty, if you do not use the pendulum test)
	☐ For routine monitoring or Pavement Management ☐ For acceptance or warranty tests ☒ Others: Pavements or pedestrian area where it is not possible to use the dynamic devise (Leave it empty, if you do not use the pendulum test)
3.7 Use this space to give any other comments about measurement devices:	

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☐	☐	☐
Accident cluster analysis	☐	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☒	☒	☒	☒	☒
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	1 pr year	1 pr year	on request	on request	on request
Time of year	May to November	May to November	May to November	May to November	May to November

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	no
Primary roads	no
Secondary roads	no
Tertiary roads	no
Urban roads	no

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☒ On every lane
☐ On the first lane only
☐ On the emergency lane
☒ On ramps or link roads
☐ Other where:</td><td colspan="2">☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☒</td><td>☐</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☐</td><td>On request</td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td>On request</td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td>On request</td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4">In Denmark the Motorways and primary roads are screened by lasers measurements calculating MPD - then road sections pointed out to have a low texture are measured by ROAR</td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:* Maintenance: Konstruktion og vedligeholdelse af veje og stier Hæfte 4 Construction: Varmt blandet asfalt, Almindelige arbejdsbeskrivelse	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☒	☒	☒	☒	☒
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	> 0.40							
Motorways	x							
Primary roads	x							
Secondary roads	x							
Tertiary roads	x							
Urban roads	x							

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: If the speed limit is above 50 km/h the required friction shall be above 0.4 if the speed limit is below 50 km/h the raod standards specifies that the pavement shall have a sufficient friction, without any further precition

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☐ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☐ Yes, the limit is °C (surface temp.) / °C (air temp.) ☒ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☒ Other where: see comments in 5.3 *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 1965 ☒ On primary roads, since *(please fill in a year date)*: 1965 ☒ On secondary roads, since *(please fill in a year date)*: 1965 ☒ On tertiary roads, since *(please fill in a year date)*: 1965 ☒ On urban roads, since *(please fill in a year date)*: 1965
	☐ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☒ Policies, regulations or standards… *please specify name / number of document:* Construction: Varmt blandet asfalt, Almindelige arbejdsbeskrivelse	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☒ Before road opening ☐ After road opening *(please fill in a time span)*:	
6.4 How many runs are taken for an acceptance test measurement?	☒ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☒ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = > 0.5 On primary roads: μ = > 0.4 On secondary roads: μ = > 0.4 On tertiary roads: μ = speedlimit dependant < 50 km/h then 0.50. => 50 km/h then 0.45 On urban roads: μ = speedlimit dependant < 50 km/h then 0.50. => 50 km/h then 0.45 *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☐ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: Normally a second test is done 3 to 4 month later to see if the wear of the bitumen film has improved the friction. If not then actions to improve the skid resistance is initiated or a Reconstruction of the road. ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☐ None See 6.7 *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 1965 ☐ On primary roads, since *(please fill in a year date)*: 1965 ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☐ Policies, regulations or standards *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☒ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	5 years *(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☒ More *(please comment)*: After construction the road becomes part of the maintenance division and then the road is monitored according to maintenance plans, appr. every year	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = > 04 On primary roads: μ = > 0.4 On secondary roads: μ = >0.4 On tertiary roads: μ = >0.4 On urban roads: μ = >0.4 *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	FRANCE
Your organisation:	LRPC of LYON
Contact details *(e.g. Email, phone number,…)*:	michel.gothie@developpement-durable.gouv.fr - phone: +33 4 72 14 32 93

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES			
Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire. *Please fill in the local name of each road class, the name of the road operator and the approximate road network length.*			
Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Autoroutes		
Road operator(s):	Government and private compagniest	Network length:	1100 km and 8400 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Route Nationales (National Roads)		
Road operator(s):	Government	Network length:	11800 km
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	First category of Departmental roads		
Road operator(s):	Departments	Network length:	60 000 km
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Second category of Departmental roads		
Road operator(s):	Departments	Network length:	320 000 km
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Communal roads		

Road operator(s):	Communes (smallest territorial division)	Network length:	550 000 km

SECTION 2. OVERVIEW OF POLICY MANAGEMENT					
2.1 Do road administrations set policies or standards for skid resistance in your country?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	☐ since	☐ since	☐ since	☐ since	☐ since
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	☒ since 1970	☒ since 1970	☒ since 1970	☒ since 1970	☒ since 1970
2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	PSV; Macrotexture, aggregates shape				
2.4 Who sets the policy or policies or standards your country?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	x	x			
2.5 Who is responsible for administering the standards and monitoring them?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	x	x			

2.6 What is the legal status of the standards in your country?		Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	Legally enforce-able	☒	☒	☐	☐	☐
	Represent best practice	☐	☐	☐	☐	☐
	Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	NF P 98 220-1 measurement of skid resistance with a low speed friction device NF P 98-220-2 Method to obtain a longitudinal friction coefficient NF 0 98_220-3 Method to obtain a sideway force friction coefficient (SFC) NF 9 P 98-220-4 Method to obtain a SFC with a SCRIM device EN 13036-1 Measurement of pavement surface macrotexture depth using a volumetric patch technique EN ISO 13473-1: Measurement of pavement surface macrotexture depth usin profilometric measurements EN 13036-4 Measurement of a friction coefficient with the Pendulum

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names	Devices are based on:			
(Please fill in the names of the devices used)	International standard	National standard	CEN technical specification	Other standard
Device 1: ADHERA	☐	☒	☒	
Device 2: SCRIM	☐	☒	☒	BSI 7941-1:1999
Device 3: GRIPTESTER	☐	☐	☒	BSI
Device 4: IMAG	☐	☐	☐	
Device 5: Pendulum	☒	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒	☐	☐	☐
Primary roads	☒	☒	☒	☐	☐
Secondary roads	☒	☒	☒	☐	☐
Tertiary roads	☒	☒	☒	☐	☐
Urban roads	☒	☒	☒	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☐	☐	☐	☐
Part of a condition index	☐	☐	☒	☐	☐
Local investigations	☒	☒	☒	☐	☐
Research tool	☒	☐	☐	☐	☐
Acceptance tests	☒	☒	☐	☐	☐
Warranty tests	☒	☒	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways	2	☐	☐	☒	☒	
Primary roads	3	☐	☐	☒	☐	
Secondary roads	3	☐	☐	☒	☒	
Tertiary roads	3	☐	☐	☒	☐	
Urban roads	3	☐	☐	☒	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Metrologic control and round robin tests each year
Device 2	Metrologic control and round robin tets each year
Device 3	Metrologic control and round robin test each year
Device 4	Metrologic control each year
Device 5	

3.6 If the pendulum test is used, to what extent?

☒ As a stand-alone measurement
☐ Only in combination with an outflow meter
☐ Others:
(Leave it empty, if you do not use the pendulum test)

☐ For routine monitoring or Pavement Management
☐ For acceptance or warranty tests
☐ Others:
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☐	☐	☐
Accident cluster analysis	☒	☒	☒	☒	☒
Response to individual crashes, e.g. police request	☒	☒	☒	☒	☒
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency		each three years			
Time of year		autumn			

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	no
Primary roads	yes. A coefficient is calculated to allow to evaluate the lower skid resistance value
Secondary roads	.no
Tertiary roads	no
Urban roads	no

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☐ On every lane
☒ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where:</td><td colspan="2">☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☐</td><td>☒</td><td>In the two directions if two separate pavements</td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4">Skid resistance measurements made with other road characteristics (texture, geometry, unevenness...) for safeties studdies</td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☐ Policies, regulations or standards… *please specify name / number of document:* There are no regulations in France concerning skid resistance. There are only limited values written sometimes in the markets for new constructions	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☒	☒	☒	☒	☒
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	good	acceptable	Need an exam	Need an urgen exam				
Motorways	>0.70	0.60 < <0.70	0.50< <0.60	<0.50				
Primary roads								
Secondary roads								
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: SFC Values with SCRIM

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☒ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☒ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☐ Improvement of skid resistance ☒ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☒ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = ? *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☐ Yes, the limit is °C (surface temp.) / °C (air temp.) ☒ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☒ Other where: Rings, main streets *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	These thresholds are only indicatives! There are no specifications in France for friction values

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 3 ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☐ Policies, regulations or standards… *please specify name / number of document:* Relative Friction values	☐ For motorways ☒ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☐ Before road opening ☒ After road opening *(please fill in a time span)*:	
6.4 How many runs are taken for an acceptance test measurement?	☒ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☒ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = No official values On primary roads: μ = No official values On secondary roads: μ = No official values On tertiary roads: μ = No official values On urban roads: μ = No official values *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☐ None Grit blasting; sand chipping; *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 3 ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☐ Policies, regulations or standards *please specify name / number of document:* LFC or SFC	☒ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	3 years *(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☒ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Germany
Your organisation:	Federal Highway Research Institute (BASt)
Contact details *(e.g. Email, phone number,…)*:	Herr E. Pullwitt, pullwitt@bast.de, +49 2204 43710

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES			
Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire. *Please fill in the local name of each road class, the name of the road operator and the approximate road network length.*			
Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Bundesautobahn		
Road operator(s):	Federal Ministry of Transport, Building and Urban Affairs	Network length:	12.550 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Bundesstraße		
Road operator(s):	Federal Ministry of Transport, Building and Urban Affairs	Network length:	40.700 km
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Landesstraße		
Road operator(s):	Federal States	Network length:	86.700 km
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Kreisstraße		
Road operator(s):	Municipalities	Network length:	91.600 km
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Kommunale Straße		

Road operator(s):	Municipalities	Network length:	231.400 km

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.1 Do road administrations set policies or standards for skid resistance in your country?	☒ since 1998	☒ since 1998	☐ since	☐ since	☐ since

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	☐ since	☐ since	☐ since	☐ since	☐ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.4 Who sets the policy or policies or standards your country?	Ministry of Transport	Ministry of Transport			

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.5 Who is responsible for administering the standards and monitoring them?	Ministry of Transport	Ministry of Transport			

2.6 What is the legal status of the standards in your country?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Legally enforce-able	☐	☐	☐	☐	☐
Represent best practice	☐	☐	☐	☐	☐
Other (please explain):	legalized by contracts	legaliz-ed by con-tracts			

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	Bald, 2002 Kamplade, 1986 Steinauer, 2004

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: SKM (SeitenKraftMessverfahren)	☐	☒	☒	
Device 2: SRT (Skid Resistance Tester)	☒	☒	☐	
Device 3: GripTester	☐	☒	☒	
Device 4: SRM (Stuttgarter Reibungsmesser; at the moment this device is not used)	☐	☒	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒	☒	☐	☐
Primary roads	☒	☒	☒	☐	☐
Secondary roads	☒	☒	☒	☐	☐
Tertiary roads	☒	☒	☒	☐	☐
Urban roads	☒	☒	☒	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☒	☐	☐	☐	☐
Part of a condition index	☒	☐	☐	☐	☐
Local investigations	☒	☒	☒	☐	☐
Research tool	☒	☒	☒	☐	☐
Acceptance tests	☒	☒	☐	☐	☐
Warranty tests	☒	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.						
Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	temporary operating approval by BASt
Device 2	temporary operating approval by BASt-licence organisations
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?	☐ As a stand-alone measurement ☒ Only in combination with an outflow meter ☐ Others: (Leave it empty, if you do not use the pendulum test)
	☐ For routine monitoring or Pavement Management ☒ For acceptance or warranty tests ☒ Others: Research tool, loval investigations (Leave it empty, if you do not use the pendulum test)
3.7 Use this space to give any other comments about measurement devices:	not for warranty tests!

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☐	☐	☐
Accident cluster analysis	☐	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☐	☐	☐	☐	☐
Other	acceptance tests	acceptance tests			

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	every 4 years	every 4 yeras			
Time of year	may to october	may to october			

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	
Primary roads	
Secondary roads	
Tertiary roads	
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☒ On every lane
☐ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where:</td><td colspan="2">☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4"></td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:* ZTV ZEB-StB	☒ For motorways ☒ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☒ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☒	☒	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☒	☒	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☒	☒	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	"1,5 Wert" = 1,5 (1,5 value)	"Warnwert" =3,5 (warning value)	"Schwellen wert" =4,5 (threshold value)					
Motorways	μ=0,53	μ=0,39	μ=0,32	(80km/h)				
Primary roads	μ=0,58	μ=0,44	μ=0,37	(60km/h)				
Secondary roads								
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments:

5.4	Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☒ Other measures *(please fill in)*: individually proved ☐ None
5.5	Based on policies, which measures have to be taken, if the values are worse than threshold level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☒ Other measures *(please fill in)*: individually proved ☐ None
5.6	In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7	In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is 50°C (surface temp.) / °C (air temp.) ☐ No
5.8	Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9	Are there any other comments regarding thresholds?	

<table>
<tr><th colspan="4">SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">6.1 Are acceptance tests required for newly built roads?</td><td>☒ Yes, …</td><td colspan="2">☒ On motorways, since (please fill in a year date): 2001
☒ On primary roads, since (please fill in a year date): 2001
☒ On secondary roads, since (please fill in a year date): 2001
☒ On tertiary roads, since (please fill in a year date): 2001
☒ On urban roads, since (please fill in a year date): 2001</td></tr>
<tr><td colspan="3">☐ No
(If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">6.2 Where are your acceptance tests based on?</td><td colspan="2">☒ Policies, regulations or standards…
please specify name / number of document:
ZTV-Asphalt
ZTV-Beton</td><td>☒ For motorways
☒ For primary roads
☒ For secondary roads
☒ For tertiary roads
☒ For urban roads</td></tr>
<tr><td colspan="2">☒ Building plans/contracts…</td><td>(Use this space to comment))</td></tr>
<tr><td>6.3 When have the acceptance tests to be taken?</td><td colspan="3">☐ Before road opening
☒ After road opening (please fill in a time span): 4 - 6 weeks</td></tr>
<tr><td>6.4 How many runs are taken for an acceptance test measurement?</td><td colspan="3">☐ One measurement per acceptance test
☒ Two measurements per acceptance test
☐ More (please comment):</td></tr>
<tr><td>6.5 Which measures are taken until the acceptance limits are verified?</td><td colspan="3">☒ Speed limits
☒ Warning signs
☐ Other measures (please fill in):
☐ None</td></tr>
<tr><td>6.6 What values have to be reached in the acceptance tests?</td><td colspan="3">On motorways: μ = 0,46 (80km/h)
On primary roads: μ = 0,51 (60 km/h)
On secondary roads: μ = 0,51 (60 km/h)
On tertiary roads: μ = 0,56 (40 km/h)
On urban roads: μ = 0,56 (40 km/h)
(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
</table>

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☒ Money deduction (as long as μ ≥) ☐ Speed limits ☐ Warning signs ☒ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☒ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

<table>
<tr><th colspan="3">SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">7.1 Are warranty tests required to check the skid resistance of roads?</td><td>☒ Yes, …</td><td>☒ On motorways, since (please fill in a year date): 2001
☒ On primary roads, since (please fill in a year date): 2001
☒ On secondary roads, since (please fill in a year date): 2001
☒ On tertiary roads, since (please fill in a year date): 2001
☒ On urban roads, since (please fill in a year date): 2001</td></tr>
<tr><td colspan="2">☐ No (If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">7.2 Where are your warranty tests based on?</td><td>☒ Policies, regulations or standards
please specify name / number of document:
ZTV-Asphalt
ZTV-Beton</td><td>☒ For motorways
☒ For primary roads
☒ For secondary roads
☐ For tertiary roads
☐ For urban roads</td></tr>
<tr><td>☒ Building plans/contracts</td><td>(Use this space to comment))</td></tr>
<tr><td>7.3 How long is the warranty period?</td><td colspan="2">4 years
(Please fill in a time span, e.g. 5 years)</td></tr>
<tr><td>7.4 How many runs are taken for a warranty test measurement?</td><td colspan="2">☐ One measurement per warranty test
☒ Two measurements per warranty test
☐ More (please comment):</td></tr>
<tr><td>7.5 What values have to be reached in the warranty tests?</td><td colspan="2">On motorways: μ = 0,43 (80 km/h)
On primary roads: μ = 0,48 (60 km/h)
On secondary roads: μ = 0,48 (60 km/h)
On tertiary roads: μ = 0,52 (40 km/h)
On urban roads: μ = 0,52 (40 km/h)
(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
<tr><td>7.6 Which measures are taken, if the values are below the limits?</td><td colspan="2">☒ Improvement of the skid resistance
☒ Money deduction (as long as μ >=)
☐ Speed limits
☐ Warning signs
☒ Reconstruction of the road
☐ Other measures (please fill in):
☐ None</td></tr>
<tr><td>7.7 Any other comments regarding warranty test measurements:</td><td colspan="2"></td></tr>
</table>

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Hungary
Your organisation:	KTI
Contact details *(e.g. Email, phone number,…)*:	gaspar.laszlo@kti.hu

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:			
Road operator(s):		Network length:	804 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:			
Road operator(s):		Network length:	7.113 km
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:			
Road operator(s):		Network length:	23.260
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:			
Road operator(s):		Network length:	
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:			
Road operator(s):		Network length:	

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.1 Do road administrations set policies or standards for skid resistance in your country?	☐ since	☐ since	☐ since	☐ since	☐ since

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	☒ since 19805	☒ since 19905	☐ since 19905	☐ since	☐ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	No

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.4 Who sets the policy or policies or standards in your country?	Ministry	Ministry	Ministry		

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.5 Who is responsible for administering the standards and monitoring them?	Ministry	Ministry	Ministry		

2.6 What is the legal status of the standards in your country?		Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	Legally enforce-able	☐	☐	☐	☐	☐
	Represent best practice	☒	☒	☒	☐	☐
	Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: SCRIM	☒	☐	☐	
Device 2: SRT	☒	☐	☐	
Device 3:	☐	☐	☐	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☐	☐	☐	☐
Primary roads	☒	☒	☐	☐	☐
Secondary roads	☒	☒	☐	☐	☐
Tertiary roads	☐	☐	☐	☐	☐
Urban roads	☐	☐	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☐	☐	☐	☐
Part of a condition index	☐	☐	☐	☐	☐
Local investigations	☒	☒	☐	☐	☐
Research tool	☒	☒	☐	☐	☐
Acceptance tests	☒	☒	☐	☐	☐
Warranty tests	☒	☒	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	No
Primary roads		☐	☐	☐	☐	No
Secondary roads		☐	☐	☐	☐	No
Tertiary roads		☐	☐	☐	☐	No
Urban roads		☐	☐	☐	☐	No

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Calibration needed
Device 2	Calibration needed
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?

☒ As a stand-alone measurement
☐ Only in combination with an outflow meter
☐ Others:
(Leave it empty, if you do not use the pendulum test)

☒ For routine monitoring or Pavement Management
☒ For acceptance or warranty tests
☐ Others:
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:	SRT device is unsafe to use due to traffic

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☒	☐	☐
Accident cluster analysis	☒	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☒	☐	☐	☐	☐
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	every 5 years	every 5 years	every 5 years		
Time of year	April-Oct	April-Oct	April-Oct		

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	none
Primary roads	none
Secondary roads	none
Tertiary roads	
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☐ On every lane
☒ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where:</td><td colspan="2">☐ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4">no</td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☐ Policies, regulations or standards… *please specify name / number of document:* VT 2-2.111 technical directives	☒ For motorways ☒ For primary roads ☒ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☒ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☒	☒	☒	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☒	☐	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	very good	good	average	poor	very poor			
Motorways	min. 65	60-65	50-60	40-50	max.39			
Primary roads	min.60	55-60	45-55	35-45	max. 34			
Secondary roads	min 55	50-55	40-50	30-40	mx 29			
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments:

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☒ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☒ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☐ Yes, the limit is °C (surface temp.) / °C (air temp.) ☒ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

<table>
<tr><th colspan="3">SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">6.1 Are acceptance tests required for newly built roads?</td><td>☐ Yes, …</td><td>☐ On motorways, since (please fill in a year date):
☐ On primary roads, since (please fill in a year date):
☐ On secondary roads, since (please fill in a year date):
☐ On tertiary roads, since (please fill in a year date):
☐ On urban roads, since (please fill in a year date):</td></tr>
<tr><td colspan="2">☒ No
(If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">6.2 Where are your acceptance tests based on?</td><td>☐ Policies, regulations or standards…
please specify name / number of document:</td><td>☐ For motorways
☐ For primary roads
☐ For secondary roads
☐ For tertiary roads
☐ For urban roads</td></tr>
<tr><td>☐ Building plans/contracts…</td><td>(Use this space to comment))</td></tr>
<tr><td>6.3 When have the acceptance tests to be taken?</td><td colspan="2">☐ Before road opening
☐ After road opening (please fill in a time span):</td></tr>
<tr><td>6.4 How many runs are taken for an acceptance test measurement?</td><td colspan="2">☐ One measurement per acceptance test
☐ Two measurements per acceptance test
☐ More (please comment):</td></tr>
<tr><td>6.5 Which measures are taken until the acceptance limits are verified?</td><td colspan="2">☐ Speed limits
☐ Warning signs
☐ Other measures (please fill in):
☐ None</td></tr>
<tr><td>6.6 What values have to be reached in the acceptance tests?</td><td colspan="2">On motorways: μ =
On primary roads: μ =
On secondary roads: μ =
On tertiary roads: μ =
On urban roads: μ =
(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
</table>

6.7 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☒ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

<table>
<tr><th colspan="4">SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">7.1 Are warranty tests required to check the skid resistance of roads?</td><td>☐ Yes, …</td><td colspan="2">☐ On motorways, since (please fill in a year date):
☐ On primary roads, since (please fill in a year date):
☐ On secondary roads, since (please fill in a year date):
☐ On tertiary roads, since (please fill in a year date):
☐ On urban roads, since (please fill in a year date):</td></tr>
<tr><td colspan="3">☒ No (If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">7.2 Where are your warranty tests based on?</td><td colspan="2">☐ Policies, regulations or standards

please specify name / number of document:</td><td>☐ For motorways
☐ For primary roads
☐ For secondary roads
☐ For tertiary roads
☐ For urban roads</td></tr>
<tr><td colspan="2">☐ Building plans/contracts</td><td>(Use this space to comment))</td></tr>
<tr><td>7.3 How long is the warranty period?</td><td colspan="3">(Please fill in a time span, e.g. 5 years)</td></tr>
<tr><td>7.4 How many runs are taken for a warranty test measurement?</td><td colspan="3">☐ One measurement per warranty test
☐ Two measurements per warranty test
☐ More (please comment):</td></tr>
<tr><td>7.5 What values have to be reached in the warranty tests?</td><td colspan="3">On motorways: μ =
On primary roads: μ =
On secondary roads: μ =
On tertiary roads: μ =
On urban roads: μ =
(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
<tr><td>7.6 Which measures are taken, if the values are below the limits?</td><td colspan="3">☐ Improvement of the skid resistance
☐ Money deduction (as long as μ >=)
☐ Speed limits
☐ Warning signs
☐ Reconstruction of the road
☐ Other measures (please fill in):
☐ None</td></tr>
<tr><td>7.7 Any other comments regarding warranty test measurements:</td><td colspan="3"></td></tr>
</table>

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Ireland
Your organisation:	TRL (completing based on own knowledge)
Contact details *(e.g. Email, phone number,…)*:	

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Motorway		
Road operator(s):	NRA	Network length:	270
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	National Primary		
Road operator(s):	NRA	Network length:	353
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	National Secondary		
Road operator(s):	NRA	Network length:	4804
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Primary / Secondary / Regional		
Road operator(s):	County councils	Network length:	889240
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:			
Road operator(s):		Network length:	

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.1 Do road administrations set policies or standards for skid resistance in your country?	☐ since	☐ since	☐ since	☐ since	☐ since
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	☒ since 1980s	☒ since 1980s	☒ since no known	☐ since	☐ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.4 Who sets the policy or policies or standards your country?					
2.5 Who is responsible for administering the standards and monitoring them?	NRA	NRA	NRA		

2.6 What is the legal status of the standards in your country?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Legally enforce-able	☐	☐	☐	☐	☐
Represent best practice	☒	☒	☒	☐	☐
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names	Devices are based on:			
(Please fill in the names of the devices used)	International standard	National standard	CEN technical specification	Other standard
Device 1: SCRIM	☐	☒	☐	BS 7941-2006
Device 2:	☐	☐	☐	
Device 3:	☐	☐	☐	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☐	☐	☐	☐
Primary roads	☒	☐	☐	☐	☐
Secondary roads	☒	☐	☐	☐	☐
Tertiary roads	☐	☐	☐	☐	☐
Urban roads	☐	☐	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☒	☐	☐	☐	☐
Part of a condition index	☐	☐	☐	☐	☐
Local investigations	☒	☐	☐	☐	☐
Research tool	☐	☐	☐	☐	☐
Acceptance tests	☐	☐	☐	☐	☐
Warranty tests	☐	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Attends UK's annual SCRIM correlation trials
Device 2	
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?	☐ As a stand-alone measurement ☐ Only in combination with an outflow meter ☐ Others: (Leave it empty, if you do not use the pendulum test)
	☐ For routine monitoring or Pavement Management ☐ For acceptance or warranty tests ☐ Others: (Leave it empty, if you do not use the pendulum test)
3.7 Use this space to give any other comments about measurement devices:	

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☒	☐	☐
Accident cluster analysis	☐	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☐	☐	☐	☐	☐
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	annually	annually	every second year		
Time of year	May - September	May - September	May - September		

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	
Primary roads	
Secondary roads	
Tertiary roads	
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☐ On every lane
☒ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where:</td><td colspan="2">☐ in each direction
☒ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☒</td><td>Half the newtork</td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4"></td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☐ Policies, regulations or standards… *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:								
Motorways								
Primary roads								
Secondary roads								
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments:

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☐ Yes, the limit is °C (surface temp.) / °C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☐ Policies, regulations or standards… *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☐ Before road opening ☐ After road opening *(please fill in a time span)*:	
6.4 How many runs are taken for an acceptance test measurement?	☐ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☐ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☐ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☐ Policies, regulations or standards *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	*(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Latvia
Your organisation:	Latvijas Valsts ceļi (Latvian State Roads)
Contact details *(e.g. Email, phone number,…)*:	Janis.barbars@lvceli.lv

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	---------		
Road operator(s):	---------	Network length:	---------
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Valsts galvenie autoceļi (Main roads)		
Road operator(s):	Latvian State roads	Network length:	1647 km
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Valsts 1. šķiras autoceļi (1.class roads)		
Road operator(s):	Latvian State roads	Network length:	5322 km
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Valsts 2. šķiras autoceļi (2. class roads)		
Road operator(s):	Latvian State roads	Network length:	13210 km
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:			
Road operator(s):		Network length:	

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.1 Do road administrations set policies or standards for skid resistance in your country?	☐ since	☒ since 2001	☒ since 2001	☒ since 2001	☐ since
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	☐ since	☒ since 2004	☒ since 2004	☐ since	☐ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.4 Who sets the policy or policies or standards your country?	---------	Latvian State Roads			---------
2.5 Who is responsible for administering the standards and monitoring them?					

2.6 What is the legal status of the standards in your country?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Legally enforce-able	☐	☐	☐	☐	☐
Represent best practice	☐	☐	☐	☐	☐
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	Autoceļu specifikācijas 2005 (http://www.lvceli.lv/LV/?i=107&DirID=42); LVS EN 13036-2

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: Grip Tester	☐	☒	☐	
Device 2:	☐	☐	☐	
Device 3:	☐	☐	☐	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☐	☐	☐	☐	☐
Primary roads	☒	☐	☐	☐	☐
Secondary roads	☒	☐	☐	☐	☐
Tertiary roads	☒	☐	☐	☐	☐
Urban roads	☐	☐	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☐	☐	☐	☐
Part of a condition index	☐	☐	☐	☐	☐
Local investigations	☐	☐	☐	☐	☐
Research tool	☐	☐	☐	☐	☐
Acceptance tests	☒	☐	☐	☐	☐
Warranty tests	☐	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	
Device 2	
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?

☐ As a stand-alone measurement
☐ Only in combination with an outflow meter
☐ Others:
(Leave it empty, if you do not use the pendulum test)

☐ For routine monitoring or Pavement Management
☐ For acceptance or warranty tests
☐ Others:
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☐	☒	☒	☐	☐
Accident cluster analysis	☐	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☐	☐	☐	☐	☐
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	-----------	Every 2 years	Every 2 years	-----------	-----------
Time of year	------------	Summer	Summer	-----------	-----------

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	
Primary roads	
Secondary roads	
Tertiary roads	
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☐ On every lane
☐ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where:</td><td colspan="2">☐ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☒</td><td>☐</td><td></td></tr>
<tr><td>Secondary roads</td><td>☒</td><td>☐</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4"></td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:* Road specifications 2005 (Autoceļu specifikācijas 2005)	☐ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other		In 2000 was made research to adapt Griptester to existing "postsoviet" standards			

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:								
Motorways								
Primary roads								
Secondary roads								
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments:

5.4	Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5	Based on policies, which measures have to be taken, if the values are worse than threshold level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6	In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7	In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☐ Yes, the limit is °C (surface temp.) / °C (air temp.) ☒ No
5.8	Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9	Are there any other comments regarding thresholds?	

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☒ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☒ On primary roads, since 2001 ☒ On secondary roads, since 2001 ☒ On tertiary roads, since 2001 ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☒ Policies, regulations or standards… *please specify name / number of document:* Road specifications 2005 (Autoceļu specifikācijas 2005)	☐ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☐ Before road opening ☒ After road opening At least 2 weaks after construction	
6.4 How many runs are taken for an acceptance test measurement?	☒ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☒ Warning signs (Sometimes) ☐ Other measures *(please fill in)*: ☒ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = ------- On primary roads, On secondary roads, On tertiary roads: μ = 0,48 if $AADT_j$ < 1500; μ = 0,54 if $AADT_j$ > 1500 On urban roads: μ = ------ *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
6.7	Before 2001 acceptance tests were made with device ППК – МАДИ – ВНИИБД (Russia)	

6.8 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☒ Money deduction ☐ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.9 Which measures are taken to increase the early life skid resistance?	☒ None *(Please fill in the measures used)*
6.10 Any other comments regarding acceptance test measurements:	

<table>
<tr><th colspan="4">SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">7.1 Are warranty tests required to check the skid resistance of roads?</td><td>☐ Yes, …</td><td colspan="2">☐ On motorways, since (please fill in a year date):
☐ On primary roads, since (please fill in a year date):
☐ On secondary roads, since (please fill in a year date):
☐ On tertiary roads, since (please fill in a year date):
☐ On urban roads, since (please fill in a year date):</td></tr>
<tr><td colspan="3">☒ No (If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">7.2 Where are your warranty tests based on?</td><td colspan="2">☐ Policies, regulations or standards
please specify name / number of document:</td><td>☐ For motorways
☐ For primary roads
☐ For secondary roads
☐ For tertiary roads
☐ For urban roads</td></tr>
<tr><td colspan="2">☐ Building plans/contracts</td><td>(Use this space to comment))</td></tr>
<tr><td>7.3 How long is the warranty period?</td><td colspan="3">(Please fill in a time span, e.g. 5 years)</td></tr>
<tr><td>7.4 How many runs are taken for a warranty test measurement?</td><td colspan="3">☐ One measurement per warranty test
☐ Two measurements per warranty test
☐ More (please comment):</td></tr>
<tr><td>7.5 What values have to be reached in the warranty tests?</td><td colspan="3">On motorways: μ =
On primary roads: μ =
On secondary roads: μ =
On tertiary roads: μ =
On urban roads: μ =
(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
<tr><td>7.6 Which measures are taken, if the values are below the limits?</td><td colspan="3">☐ Improvement of the skid resistance
☐ Money deduction (as long as μ >=)
☐ Speed limits
☐ Warning signs
☐ Reconstruction of the road
☐ Other measures (please fill in):
☐ None</td></tr>
<tr><td>7.7 Any other comments regarding warranty test measurements:</td><td colspan="3"></td></tr>
</table>

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

TYROSAFE
Task 1.1

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Netherlands
Your organisation:	Rijkswaterstaat
Contact details *(e.g. Email, phone number,…)*:	erik.vos@rws.nl

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES			
Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire. *Please fill in the local name of each road class, the name of the road operator and the approximate road network length.*			
Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	autosnelwegen and autowegen		
Road operator(s):	central governent, Ministry of Transport, Public Works and Water Management	Network length:	3150 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Provincial roads		
Road operator(s):	Provincial government	Network length:	ca 10.000 km including secondary roads
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Provincial roads		
Road operator(s):	Provincial government	Network length:	
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	local roads		
Road operator(s):	municipalities	Network length:	110.000 km incl urban/residential roads
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	local roads		

Road operator(s):	municipalities	Network length:	

SECTION 2. OVERVIEW OF POLICY MANAGEMENT					
2.1 Do road administrations set policies or standards for skid resistance in your country?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	☒ since 1954	☒ since 1987	☒ since 1987	☒ since 1987	☒ since 1987
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	☒ since 1954	☒ since +/- 1985	☒ since +/- 1985	☒ since +/- 1985	☒ since +/- 1985
2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	material specification (PSV)				
2.4 Who sets the policy or policies or standards your country?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	Ministry of Transport, Public Works and Water Manageme nt	CROW	CROW	CROW	CROW
2.5 Who is responsible for administering the standards and monitoring them?	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	Rijkswaters taat	Provincial governmen t	Provincial governmen t	Municipaliti es	Municipaliti es

2.6 What is the legal status of the standards in your country?		Motorways	Primary roads	Secondar y roads	Tertiary roads	Urban roads
	Legally enforce-able	☒	☐	☐	☐	☐
	Represent best practice	☐	☒	☒	☒	☒
	Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	Richtlijnen voor het onderhoud van Rijkswegen, Ministry of Transport, Public Works and Water management, Den Haag (Su), 1983, Ministeriele nota piece number 17600 B CROW "Standaard RAW bepalingen 2005" Proef 150 (Standard specifications for contracts, test method 150) CROW publication 20A/B/C "Rational Pavement Management" 1987

	CEN TS The RWS-NL skid resistance trailer

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: RWS-NL skid resistance trailer	☐	☒	☒	
Device 2: RWS NL ROAR device	☐	☒	☒	
Device 3:	☐	☐	☐	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒	☐	☐	☐
Primary roads	☒	☐	☐	☐	☐
Secondary roads	☒	☐	☐	☐	☐
Tertiary roads	☒	☐	☐	☐	☐
Urban roads	☒	☐	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☒	☒	☐	☐	☐
Part of a condition index	☒	☐	☐	☐	☐
Local investigations	☒	☐	☐	☐	☐
Research tool	☒	☒	☐	☐	☐
Acceptance tests	☒	☐	☐	☐	☐
Warranty tests	☒	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways	RWS-NL skid resistance trailer and ROAR	☐	☐	☐	☒	1:1 at 70 km/h
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	all devices have to participate in a montly correlation trial with strict specifications for acceptance
Device 2	this device participates in the montly correlation trial
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?

☒ As a stand-alone measurement
☐ Only in combination with an outflow meter
☒ Others: 1. For testing of PSV, pavement element products, and markings, re EN 1097-8, 1338-1344 and 1436. 2. Only occasionally in situ, mainly for cycle paths and pedestrian areas
(Leave it empty, if you do not use the pendulum test)

☐ For routine monitoring or Pavement Management
☐ For acceptance or warranty tests
☒ Others: 1. For quality control and certification of pavement element products. 2. For in-situ investigation, mostly only after incidents/accidents, but without legal thresholds. 3. For research.
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☐	☐	☐	☐
Accident cluster analysis	☒	☒	☒	☐	☐
Response to individual crashes, e.g. police request	☒	☒	☒	☒	☒
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	every two year	none	none	none	none
Time of year	Jan -June and Sept -Dec	Jan -June and Sept -Dec	Jan -June and Sept -Dec	Jan -June and Sept -Dec	Jan -June and Sept -Dec

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	none
Primary roads	none
Secondary roads	none
Tertiary roads	none
Urban roads	none

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☐ On every lane
☒ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where: when only the first lane is renewed or when skid elvel of first lane is near the threshold, then also the other lanes are monitored</td><td colspan="2">☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4"></td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS		
5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:* For motorways: Richtlijnen voor het onderhoud van Rijkswegen, Ministry of Transport, Public Works and Water management, Den Haag (Su), 1983, Ministriele nota , piece number 17600 B For other roads: CROW publication 20A/B/C "Rational Pavement Management" 1987	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☒ Building plans/contracts…	For new works, acceptance tests for skid resistance are generally included in the contract *(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other	based on statistical analysis of accidents and skid measurements for the network	copied from the motorways	copied from the motorways	copied from the motorways	copied from the motorways

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	threshold	warning level						
Motorways	0,38	NA						

Primary roads	0,38	0,45						
Secondary roads	0,38	0,45						
Tertiary roads	0,38	0,45						
Urban roads	0,38	0,45						

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: The threshold level is the minimum required level. Below this level traffic warnings sign are obligatory and maintenance measures to improve skid resistance should be carried out. We do not use warning levels for motorways

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☒ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☐ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: when minimum requiered level is exceeded with more than 0,02 on motorways, then a speed limit of 90 km/h is needed ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is 45°C (surface temp.) / 30°C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	The warning level for non-motorways is intended to alert the road authority that this road may need repeated skid resistance measurement and possibly improvement in 2-5 years time

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 1969 ☒ On primary roads, since *(please fill in a year date)*: 1969 ☒ On secondary roads, since *(please fill in a year date)*: 1969 ☒ On tertiary roads, since *(please fill in a year date)*: 1969 ☒ On urban roads, since *(please fill in a year date)*: 1969
	☐ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☒ Policies, regulations or standards… *please specify name / number of document:* CROW "Standaard RAW bepalingen 2005" (Standard specifications for contracts)	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☒ Before road opening ☒ After road opening *(please fill in a time span)*:	
6.4 How many runs are taken for an acceptance test measurement?	☒ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☐ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = 0,40 On primary roads: μ = 0,52 for gritted surfacings, 0,45 for SMA, unspecified in the standard for non-gritted surfacings (but a requirement of 0,45 is advised for inclusion in contracts), On secondary roads: μ = see primary roads On tertiary roads: μ = see primary roads On urban roads: μ = see primary roads *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☒ Money deduction (as long as μ ≥ 0,45) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☐ None For dense graded mixes gritting is standard. For SMA, gritting is increasingly used. For porous asphalt and other slilent surfacings, mostly no measures are taken, although research is in progress investigating gritting with 0-3 mm aggregate. *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	For motorways, acceptance tests are executed before road opening, and no money deduction is done, only improvement when necessary. In most motorway contracts since 2005, the requirement of mu > 0,40 has to be fullfilled from day zero until the end of a seven year warranty period. On other roads, acceptance tests are mostly executed between two-six weeks after road opening (if executed at all, since most municipalities don't require testing, even if they use skid resistance requirements). Improvement has to be done when mu < 0,45. Money deduction is done when 0,38 < mu < 0,51 (or 0,45 for SMA and similar)

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: +/- 1980 ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☒ Policies, regulations or standards *please specify name / number of document:* CROW "Standaard RAW bepalingen 2005" (Standard specifications for contracts) CROW publication 20A/B/C "Rational Pavement Management" 1987	☐ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☒ Building plans/contracts	For motorway contracts since about 2005, a warranty period of 7 years is required, with requirements for skid resistance and obligatory testing at the end of the warranty period. *(Use this space to comment))*
7.3 How long is the warranty period?	7 years for motorways and 3 years for the other roads *(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☒ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = 0,38 On primary roads: μ = 0,38 On secondary roads: μ = 0,38 On tertiary roads: μ = 0,38 On urban roads: μ = 0,38 *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding	For motorways, regional departments of Rijkswaterstaat are free to apply	

warranty test measurements:	bonus/malus systems for the end-of-warranty level of skid resistance to stimulate better performance For other roads, a 3 year warranty period is specified in the Standard Specifications for Contracts, but without obligation to test skid resistance, and without any clear threshold level. Such a threshold level is derived from the monitoring/maintenance guidelines. In practice, warranty tests are hardly ever executed on non-motorways.

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Poland
Your organisation:	IBDiM (Road and Bridge Research Institute)
Contact details *(e.g. Email, phone number,…)*:	Przemysław Harasim, pharasim@ibdim.edu.pl

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Autostrady (Motorways)		
Road operator(s):	GDDKiA (General Directorate for National Roads and Motorways)	Network length:	675 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Drogi krajowe (National roads)		
Road operator(s):	GDDKiA (General Directorate for National Roads and Motorways)	Network length:	17.582 km
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Drogi wojewódzkie (Provincial roads)		
Road operator(s):	Provincial roads administration	Network length:	28.444 km
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Drogi wojewódzkie (County roads)		
Road operator(s):	County roads administration	Network length:	unknown
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Drogi miejskie (Urban roads)		

Road operator(s):	Urban roads administration	Network length:	unknown

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.1 Do road administrations set policies or standards for skid resistance in your country?	☒ since	☒ since	☒ since	☐ since	☒ since

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	☐ since	☐ since	☐ since	☐ since	☐ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	Texture on paid motorways

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.4 Who sets the policy or policies or standards your country?	Minister of transport	Minister of transport	Minister of transport		Minister of transport

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.5 Who is responsible for administering the standards and monitoring them?	GDDKiA	GDDKiA	Provincial roads adminnistra tion		Urban roads administrati on

2.6 What is the legal status of the standards in your country?	Motorways	Primary roads	Secondar y roads	Tertiary roads	Urban roads
Legally enforce-able	☒	☒	☐	☐	☐
Represent best practice	☐	☐	☒	☐	☒
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	Dz.U.99.43.430, order of Minister of transpotr Dz.U.02.12.116, order of Minister of transpotr SOSN, order of Director of GDDKiA

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names	Devices are based on:			
(Please fill in the names of the devices used)	International standard	National standard	CEN technical specification	Other standard
Device 1: SRT	☒	☐	☐	SOSN
Device 2:	☐	☐	☐	
Device 3:	☐	☐	☐	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☐	☐	☐	☐
Primary roads	☒	☐	☐	☐	☐
Secondary roads	☒	☐	☐	☐	☐
Tertiary roads	☐	☐	☐	☐	☐
Urban roads	☒	☐	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☒	☐	☐	☐	☐
Part of a condition index	☒	☐	☐	☐	☐
Local investigations	☒	☐	☐	☐	☐
Research tool	☒	☐	☐	☐	☐
Acceptance tests	☒	☐	☐	☐	☐
Warranty tests	☐	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Harmonisation test (9 devices)
Device 2	
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?	☐ As a stand-alone measurement ☐ Only in combination with an outflow meter ☐ Others: (Leave it empty, if you do not use the pendulum test)
	☐ For routine monitoring or Pavement Management ☐ For acceptance or warranty tests ☐ Others: (Leave it empty, if you do not use the pendulum test)
3.7 Use this space to give any other comments about measurement devices:	

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☐	☐	☐
Accident cluster analysis	☐	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☐	☐	☐	☐	☐
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	annually (paid motorways)	every 2nd year	on demand		on demand
Time of year		May-Oct			

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	
Primary roads	It is established time of the year of measurements
Secondary roads	
Tertiary roads	
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☒ On every lane
☐ On the first lane only
☐ On the emergency lane
☒ On ramps or link roads
☐ Other where:</td><td colspan="2">☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☒</td><td>☒</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☐</td><td>on demand</td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td>on demand</td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4"></td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:*	☒ For motorways ☒ For primary roads ☒ For secondary roads ☐ For tertiary roads ☒ For urban roads
	☒ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	Good	Fair	Poor	Very poor				
Motorways	*							
Primary roads	>= 0,52	0,37 - 0,51	0,30 - 0,36	<=0,29				
Secondary roads								
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: * level depends on measured macro-texture (paid motorways), also primary roads criteria

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☐ Yes, the limit is °C (surface temp.) / °C (air temp.) ☒ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 1997 ☒ On primary roads, since *(please fill in a year date)*: 2004 ☒ On secondary roads, since *(please fill in a year date)*: 2004 ☐ On tertiary roads, since *(please fill in a year date)*: ☒ On urban roads, since *(please fill in a year date)*: 2004
	☐ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☒ Policies, regulations or standards… *please specify name / number of document:* Dz.U.99.43.430, Dz.U.99.43.430	☒ For motorways ☒ For primary roads ☒ For secondary roads ☐ For tertiary roads ☒ For urban roads
	☒ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☒ Before road opening ☒ After road opening *(please fill in a time span)*:	
6.4 How many runs are taken for an acceptance test measurement?	☒ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☒ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = 0,52/30km/h 0,46/60km/h 0,42/90km/h 0,37/120km/h On primary roads: μ = 0,48/30km/h 0,39/60km/h 0,32/90km/h 0,30/120km/h On secondary roads: μ = 0,48/30km/h 0,39/60km/h 0,32/90km/h 0,30/120km/h On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☒ Money deduction (as long as μ ≥) ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☒ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☐ Policies, regulations or standards *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	*(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Slovakia
Your organisation:	University of Zilina
Contact details *(e.g. Email, phone number,…)*:	Jan Celko, jan.celko@fstav.uniza.sk Matus Kovac, kovac@fstav.uniza.sk

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Dialnice, Rychlostne cesty		
Road operator(s):	National Highways Company	Network length:	411 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Cesty I. triedy		
Road operator(s):	Slovak Road Administration	Network length:	3.263 km
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Cesty II. triedy		
Road operator(s):	Self-governing region	Network length:	3.734 km
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Cesty III. triedy		
Road operator(s):	Self-governing region	Network length:	10.401 km
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Miestne komunikacie		
Road operator(s):	Municipalities	Network length:	25 220

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

2.1 Do road administrations set policies or standards for skid resistance in your country?		Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
		☒ since 2000	☒ since 2000	☒ since 2000	☒ since 2000	☒ since 2000
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?		Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
		☒ since 1974	☒ since 1974	☒ since 1974	☒ since 1974	☒ since 1974
2.3 What other measures are used to control skid resistance (e.g. materials specifications)?	material specification					
2.4 Who sets the policy or policies or standards your country?		Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
		Ministry of Transport , Post and Telecommunication.	Ministry of Transport , Post and Telecommunication.	Ministry of Transport , Post and Telecommunication.	Ministry of Transport , Post and Telecommunication.	
2.5 Who is responsible for administering the standards and monitoring them?		Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
		Ministry of Transport , Post and Telecommunication. National Highways Company	Ministry of Transport , Post and Telecommunication. Slovak Road Administration	Ministry of Transport , Post and Telecommunication.Self-governing region	Ministry of Transport , Post and Telecommunication. Self-governing region	Municipalities.
2.6 What is the legal status of the standards in your country?		Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
	Legally enforce-able	☒	☒	☐	☐	☐
	Represent best practice	☐	☐	☒	☒	☐
	Other (please explain):					
2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	TP 14/2006, order Ministry of Transport, Post and Telecommunications STN 736177, STN 736195 EN STN 13036-4					

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names	Devices are based on:			
(Please fill in the names of the devices used)	International standard	National standard	CEN technical specification	Other standard
Device 1: Pendulum (SRT)	☒	☒	☐	
Device 2: Skiddometer BV 11	☐	☐	☒	
Device 3: Profilograph GE	☐	☐	☒	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☐	☒	☒	☐	☐
Primary roads	☐	☒	☒	☐	☐
Secondary roads	☒	☒	☒	☐	☐
Tertiary roads	☒	☒	☐	☐	☐
Urban roads	☒	☐	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☒	☐	☐	☐
Part of a condition index	☐	☐	☒	☐	☐
Local investigations	☒	☒	☐	☐	☐
Research tool	☒	☒	☐	☐	☐
Acceptance tests	☐	☒	☐	☐	☐
Warranty tests	☐	☒	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	no
Primary roads		☐	☐	☐	☐	no
Secondary roads		☐	☐	☐	☐	no
Tertiary roads		☐	☐	☐	☐	no
Urban roads		☐	☐	☐	☐	no

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	calibration
Device 2	calibration
Device 3	calibration
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?

☒ As a stand-alone measurement
☐ Only in combination with an outflow meter
☐ Others:
(Leave it empty, if you do not use the pendulum test)

☐ For routine monitoring or Pavement Management
☐ For acceptance or warranty tests
☒ Others: for oriented evaluation
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☒	☐	☐
Accident cluster analysis	☐	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☒	☒	☒	☒	☒
Other	acceptance test	acceptance test			

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	yearly	yearly	every 2 years	by request	
Time of year	spring - autumn	spring - autumn	spring - autumn		

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	no
Primary roads	no
Secondary roads	no
Tertiary roads	no
Urban roads	no

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td>4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td>☒ On every lane
☐ On the first lane only
☐ On the emergency lane
☒ On ramps or link roads
☐ Other where:</td><td>☒ in each direction
☐ only in one direction</td></tr>
</table>

<table>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☒</td><td>☐</td><td></td></tr>
<tr><td>Secondary roads</td><td>☒</td><td>☐</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4"></td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:* TP 14/2006	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☒	☒	☒	☒	☒
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	Poor	Fair	Very good					
Motorways	IFI < 0.15	0.15 <=IFI<=0.30	IFI >0.30					
Primary roads	IFI < 0.15	0.15 <=IFI<=0.30	IFI >0.30					
Secondary roads	IFI <0.15	0.15 <=IFI<=0.45	IFI >0.45					
Tertiary roads	IFI <0.15	0.15 <=IFI<=0.45	IFI >0.45					
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available) Comments:	
5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☒ Other measures *(please fill in)*: repeat ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☒ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = undefined *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☐ Yes, the limit is °C (surface temp.) / °C (air temp.) ☒ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE

6.1 Are acceptance tests required for newly built roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 2000 ☒ On primary roads, since *(please fill in a year date)*: 2000 ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☒ Policies, regulations or standards… *please specify name / number of document:* TP 14/2006	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☒ Before road opening ☐ After road opening *(please fill in a time span)*:	
6.4 How many runs are taken for an acceptance test measurement?	☒ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☒ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☐ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = 0.30 On primary roads: μ = 0.30 On secondary roads: μ = 0.45 On tertiary roads: μ = 0.45 On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☒ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	6.1 Yes, but only on request.

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☒ Yes, …	☒ On motorways, since *(please fill in a year date)*: 2002 ☒ On primary roads, since *(please fill in a year date)*: 2002 ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☐ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☒ Policies, regulations or standards *please specify name / number of document:* TP SSC 14/2006	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☐ For urban roads
	☒ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	3 - 5 years *(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☒ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = 0.30 On primary roads: μ = 0.30 On secondary roads: μ = 0.45 On tertiary roads: μ = 0.45 On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Slovenia
Your organisation:	ZAG Ljubljana
Contact details *(e.g. Email, phone number,…)*:	Darko Kokot, darko.kokot@zag.si

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES			
Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire. *Please fill in the local name of each road class, the name of the road operator and the approximate road network length.*			
Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Avtoceste in hitre ceste		
Road operator(s):	DARS, Motorway Company in the Republic of Slovenia	Network length:	514
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Glavne ceste		
Road operator(s):	Slovenian Roads Agency	Network length:	948
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Regionalne ceste		
Road operator(s):	Slovenian Roads Agency	Network length:	5.002
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Lokalne ceste		
Road operator(s):	Municipalities	Network length:	13.811
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Mestne ceste		
Road operator(s):	Municipalities	Network length:	unknown

<table>
<tr><th colspan="7">SECTION 2. OVERVIEW OF POLICY MANAGEMENT</th></tr>
<tr><td rowspan="2">2.1 Do road administrations set policies or standards for skid resistance in your country?</td><td colspan="2">Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td colspan="2">☒ since 2003</td><td>☒ since 2003</td><td>☒ since 2003</td><td>☐ since</td><td>☐ since</td></tr>
<tr><td rowspan="2">2.2 Even if they do not have a formal policy, do they make skid resistance measurements?</td><td colspan="2">Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td colspan="2">☒ since 2003</td><td>☒ since 2000</td><td>☒ since 2000</td><td>☐ since</td><td>☐ since</td></tr>
<tr><td>2.3 What other measures are used to control skid resistance (e.g. materials specifications)?</td><td colspan="6">Polishing values for stones</td></tr>
<tr><td rowspan="2">2.4 Who sets the policy or policies or standards your country?</td><td colspan="2">Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td colspan="2">Technical groups within Road Agency</td><td>Technical groups within Road Agency</td><td>Technical groups within Road Agency</td><td></td><td></td></tr>
<tr><td rowspan="2">2.5 Who is responsible for administering the standards and monitoring them?</td><td colspan="2">Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td colspan="2">Road Agency</td><td>Road Agency</td><td>Road Agency</td><td></td><td></td></tr>
<tr><td rowspan="4">2.6 What is the legal status of the standards in your country?</td><td></td><td>Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td>Legally enforce-able</td><td>☒</td><td>☒</td><td>☒</td><td>☐</td><td>☐</td></tr>
<tr><td>Represent best practice</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Other (please explain):</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:</td><td colspan="6">Technical specification for roads TSC 06.620: Road pavement characteristics Skid resistance; Ministry of transport, Slovenian Road Agency, 2003.</td></tr>
</table>

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: British pendulum	☐	☒	☒	
Device 2: SCRIMTEX	☐	☒	☐	
Device 3:	☐	☐	☐	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒	☐	☐	☐
Primary roads	☒	☒	☐	☐	☐
Secondary roads	☒	☒	☐	☐	☐
Tertiary roads	☒	☒	☐	☐	☐
Urban roads	☒	☒	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☐	☐	☐	☐
Part of a condition index	☐	☐	☐	☐	☐
Local investigations	☒	☒	☐	☐	☐
Research tool	☒	☒	☐	☐	☐
Acceptance tests	☐	☒	☐	☐	☐
Warranty tests	☐	☒	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☐	☐	
Tertiary roads		☐	☐	☐	☐	
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	calibration
Device 2	calibration procedures defined
Device 3	
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?	☐ As a stand-alone measurement ☐ Only in combination with an outflow meter ☒ Others: in combination with sand patch method (Leave it empty, if you do not use the pendulum test)
	☐ For routine monitoring or Pavement Management ☐ For acceptance or warranty tests ☒ Others: for local investigations, for research (Leave it empty, if you do not use the pendulum test)
3.7 Use this space to give any other comments about measurement devices:	

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☒	☐	☐
Accident cluster analysis	☐	☐	☐	☐	☐
Response to individual crashes, e.g. police request	☒	☒	☒	☒	☒
Other	acceptance / warranty tests				

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	3 years	1/4 network each year	1/4 network each year		
Time of year	summer	Apr-Oct	Apr-Oct		

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	n/a
Primary roads	n/a
Secondary roads	n/a
Tertiary roads	n/a
Urban roads	n/a

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="4">☐ On every lane
☒ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where:

☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☒</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4"></td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS		
5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:* Technical specification for roads TSC 06.620: Road pavement characteristics Skid resistance; Ministry of transport, Slovenian Road Agency, 2003.	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*	UK, Germany	UK, Germany	UK, Germany	UK, Germany	UK, Germany
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other					

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	very poor	poor	fair	good	very good			
Motorways	<42	42-48	49-52	53-63	>63			
Primary roads								
Secondary roads								
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: stated values for measuring speed 50 km/h; thresholds set for speeds 30 - 90 km /h; thresholds are for speed and temperature corrected sideway force coefficients

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☒ Accident analysis ☐ Other measures *(please fill in)*: special attention ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☒ Speed limits ☒ Warning signs ☒ Reconstruction of the road ☒ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is 5 - 50°C (surface temp.) / °C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

<table>
<tr><th colspan="3">SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">6.1 Are acceptance tests required for newly built roads?</td><td>☒ Yes, …</td><td>☒ On motorways, since (please fill in a year date): 2004
☐ On primary roads, since (please fill in a year date):
☐ On secondary roads, since (please fill in a year date):
☐ On tertiary roads, since (please fill in a year date):
☐ On urban roads, since (please fill in a year date):</td></tr>
<tr><td colspan="2">☐ No
(If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">6.2 Where are your acceptance tests based on?</td><td>☒ Policies, regulations or standards…
please specify name / number of document:
Technical specification for roads TSC 06.620: Road pavement characteristics Skid resistance; Ministry of transport, Slovenian Road Agency, 2003.</td><td>☒ For motorways
☐ For primary roads
☐ For secondary roads
☐ For tertiary roads
☐ For urban roads</td></tr>
<tr><td>☐ Building plans/contracts…</td><td>(Use this space to comment))</td></tr>
<tr><td>6.3 When have the acceptance tests to be taken?</td><td colspan="2">☐ Before road opening
☒ After road opening (please fill in a time span): around 6 months</td></tr>
<tr><td>6.4 How many runs are taken for an acceptance test measurement?</td><td colspan="2">☒ One measurement per acceptance test
☐ Two measurements per acceptance test
☐ More (please comment):</td></tr>
<tr><td>6.5 Which measures are taken until the acceptance limits are verified?</td><td colspan="2">☐ Speed limits
☐ Warning signs
☐ Other measures (please fill in):
☒ None</td></tr>
<tr><td>6.6 What values have to be reached in the acceptance tests?</td><td colspan="2">On motorways: μ = SFC >= 43 at measuring speed 80 km / h; thresholds for speeds 30 - 90 km/h
On primary roads: μ =
On secondary roads: μ =
On tertiary roads: μ =
On urban roads: μ =
(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
</table>

6.7	Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☒ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8	Which measures are taken to increase the early life skid resistance?	☒ None *(Please fill in the measures used)*
6.9	Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☐ Policies, regulations or standards *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	*(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	Sweden
Your organisation:	VTI
Contact details *(e.g. Email, phone number,…)*:	leif.sjogren@vti.se Phone:+4613204359

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Motorväg		
Road operator(s):	Swedish Road Administration (SRA)	Network length:	2400 km
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Riksväg		
Road operator(s):	Swedish Road Administration (SRA)	Network length:	12900 km
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Sekundär länsväg		
Road operator(s):	Swedish Road Administration (SRA)	Network length:	11000 km
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Teritiär länsväg		
Road operator(s):	Swedish Road Administration (SRA)	Network length:	72000 km
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Komunala och enskilda vägarr		
Road operator(s):	Kommunen	Network length:	4100+21000 km

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

Question	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.1 Do road administrations set policies or standards for skid resistance in your country?	☒ since 1983	☒ since 1983	☒ since 1983	☒ since	☐ since
2.2 Even if they do not have a formal policy, do they make skid resistance measurements?	☒ since 1983	☒ since 1983	☒ since 1983	☒ since	☐ since

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?

Swedish Road Administration (SRA)

Question	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
2.4 Who sets the policy or policies or standards your country?	SRA	SRA	SRA	SRA	
2.5 Who is responsible for administering the standards and monitoring them?	SRA	SRA	SRA	SRA	

2.6 What is the legal status of the standards in your country?

	Motorways	Primary roads	Secondar y roads	Tertiary roads	Urban roads
Legally enforce-able	☐	☐	☐	☐	☐
Represent best practice	☒	☒	☒	☒	☐
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:

VVMB 104 - Bestämning av friktion på belagd yta, Vägverket 1990:117

ATB VÄG 2005 VV Publication 2005:112

ATB Vinter 2003. VV Publication 2002:148

SS-EN 1436:1997 (Road marking materials, Road marking performance for road users)

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names	Devices are based on:			
(Please fill in the names of the devices used)	International standard	National standard	CEN technical specification	Other standard
Device 1: SAAB Friction Tester	☐	☒	☐	
Device 2: BV11	☐	☒	☐	
Device 3: Pendelum	☒	☐	☐	
Device 4: Portabel friction tester	☐	☒	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒	☐	☐	☐
Primary roads	☒	☒	☐	☐	☐
Secondary roads	☒	☒	☐	☐	☐
Tertiary roads	☒	☒	☐	☐	☐
Urban roads	☒	☒	☐	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☐	☐	☐	☐	☐
Part of a condition index	☐	☐	☐	☐	☐
Local investigations	☒	☒	☐	☐	☐
Research tool	☒	☒	☒	☒	☐
Acceptance tests	☒	☒	☐	☐	☐
Warranty tests	☒	☒	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways	SAAB Friction tester, BV11	☐	☐	☐	☐	considered equal
Primary roads	SAAB Friction tester, BV11	☐	☐	☐	☐	considered equal
Secondary roads	SAAB Friction tester, BV11	☐	☐	☐	☐	considered equal
Tertiary roads	SAAB Friction tester, BV11	☐	☐	☐	☐	considered equal
Urban roads	SAAB Friction tester, BV11	☐	☐	☐	☐	considered equal

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Calibrated and functional control at VTI, internal quality assurance
Device 2	Calibrated and functional control at VTI, internal quality assurance
Device 3	internal quality assurance
Device 4	internal quality assurance
Device 5	

3.6 If the pendulum test is used, to what extent?

☒ As a stand-alone measurement
☐ Only in combination with an outflow meter
☐ Others:
(Leave it empty, if you do not use the pendulum test)

☐ For routine monitoring or Pavement Management
☐ For acceptance or warranty tests
☒ Others: research
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☐	☐	☐	☐	☐
Accident cluster analysis	☒	☒	☒	☒	☒
Response to individual crashes, e.g. police request	☒	☒	☒	☐	☒
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	seldom	seldom	seldom	never?	more frequently
Time of year	mainly winter season	mainly winter season	mainly winter season	never?	all year

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	two types of procdures, one for winter and one for summer condition (special devices are used in winter)
Primary roads	two types of procdures, one for winter and one for summer condition (special devices are used in winter)
Secondary roads	two types of procdures, one for winter and one for summer condition (special devices are used in winter)
Tertiary roads	
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="2">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="3">☐ On every lane
☐ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where:</td><td>☐ in each direction
☐ only in one direction</td></tr>
<tr><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td rowspan="5">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td>Primary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4">No systematic measurements is done</td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:*	☒ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☒ For urban roads
	☒ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☐	☐	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☒	☒	☒	☒	☒
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other	Engineering experinec	Engineering experinec	Engineering experinec	Engineering experinec	Engineering experinec

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, …) as used in your country:

Levels:	0.5							
Motorways	0.5							
Primary roads	0.5							
Secondary roads	0.5							
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: The above is for summer condition. Lateral diffrences maximum 0.25 In winter time the friction level shall be more than 0.25, 0.30 or 0.35 depending on road type, weather type and part of the road

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☒ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = 0.25 to 0.35, see comment 5.3 *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is °C (surface temp.) / 5°C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☒ Policies, regulations or standards… *please specify name / number of document:* see question 2.7	☒ For motorways ☒ For primary roads ☒ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☒ Building plans/contracts…	Can be specified in individual contracts *(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☐ Before road opening ☐ After road opening *(please fill in a time span)*: depends on agreement in contract	
6.4 How many runs are taken for an acceptance test measurement?	☐ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*: depends on agreement in contract	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☐ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: $\mu = 0.5$ On primary roads: $\mu = 0.5$ On secondary roads: $\mu = 0.5$ On tertiary roads: $\mu = 0.5$ On urban roads: $\mu = 0.5$ *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☐ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE

7.1 Are warranty tests required to check the skid resistance of roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☒ Policies, regulations or standards *please specify name / number of document:*	☒ For motorways ☒ For primary roads ☒ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☒ Building plans/contracts	Can be specified in separate contracts *(Use this space to comment))*
7.3 How long is the warranty period?	varies *(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = 0.5 On primary roads: μ = 0.5 On secondary roads: μ = 0.5 On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	United Kingdom
Your organisation:	TRL
Contact details *(e.g. Email, phone number,…)*:	

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES			
Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire. *Please fill in the local name of each road class, the name of the road operator and the approximate road network length.*			
Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	Motorway		
Road operator(s):	Highways Agency	Network length:	3750
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	Trunk roads		
Road operator(s):	Highways Agency	Network length:	7500
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	Principal Roads (A roads)		
Road operator(s):	Local Authorities	Network length:	37500
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	Secondary Roads (B, C and Unclassified)		
Road operator(s):	Local Authorities	Network length:	326250
Urban roads / Residential roads	• Roads in urban areas • Typically subject to a speed limit of 50 km/h (or equivalent) or less		
Local name in your country:	Urban roads		
Road operator(s):	Local Authorities	Network length:	detail not known

<table>
<tr><th colspan="7">SECTION 2. OVERVIEW OF POLICY MANAGEMENT</th></tr>
<tr><td rowspan="2">2.1 Do road administrations set policies or standards for skid resistance in your country?</td><td colspan="2">Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td colspan="2">☒ since 1988</td><td>☒ since 1988</td><td>☒ since 1988</td><td>☒ since 1990</td><td>☒ since 1990</td></tr>
<tr><td rowspan="2">2.2 Even if they do not have a formal policy, do they make skid resistance measurements?</td><td colspan="2">Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td colspan="2">☐ since</td><td>☐ since</td><td>☒ since 1990</td><td>☒ since 1990</td><td>☒ since 1990</td></tr>
<tr><td>2.3 What other measures are used to control skid resistance (e.g. materials specifications)?</td><td colspan="6"></td></tr>
<tr><td rowspan="2">2.4 Who sets the policy or policies or standards your country?</td><td colspan="2">Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td colspan="2">Highways Agency</td><td>Highways Agency</td><td>Individual Local Authorities</td><td>Individual Local Authorities</td><td>Individual Local Authorities</td></tr>
<tr><td rowspan="2">2.5 Who is responsible for administering the standards and monitoring them?</td><td colspan="2">Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td colspan="2">Highways Agency</td><td>Highways Agency</td><td>Individual Local Authorities</td><td>Inidividual Local Authorities</td><td>Individual Local Authorities</td></tr>
<tr><td rowspan="4">2.6 What is the legal status of the standards in your country?</td><td></td><td>Motorways</td><td>Primary roads</td><td>Secondary roads</td><td>Tertiary roads</td><td>Urban roads</td></tr>
<tr><td>Legally enforce-able</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td></tr>
<tr><td>Represent best practice</td><td>☒</td><td>☒</td><td>☒</td><td>☒</td><td>☒</td></tr>
<tr><td>Other (please explain):</td><td>In litigation reference will be made to any policy that exists and how it has been applied in relation to</td><td>as motorways</td><td>as motorways</td><td>as motorways</td><td>as motorways</td></tr>
</table>

		the relevant length of road concerned					
2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:	Design Manual for Roads and Bridges, Volume 7, HD28/04. Interim Advice Note IAN98 - the standard and supporting advice for Motorways and Trunk Roads Local Authorities Association Code of Good Practice - provides general guidance Many documents written by individual Local Authorities						

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names	Devices are based on:			
(Please fill in the names of the devices used)	International standard	National standard	CEN technical specification	Other standard
Device 1: SCRIM	☐	☒	☐	
Device 2: PFT	☐	☐	☐	ASTM
Device 3: Grip Tester	☐	☒	☐	
Device 4: Pendulum Tester	☒	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☒	☐	☐	☐
Primary roads	☒	☒	☐	☐	☐
Secondary roads	☒	☒	☒	☒	☐
Tertiary roads	☒	☒	☒	☒	☐
Urban roads	☐	☐	☒	☒	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☒	☐	☒	☐	☐
Part of a condition index	☐	☐	☐	☐	☐
Local investigations	☒	☒	☒	☒	☐
Research tool	☒	☒	☒	☒	☐
Acceptance tests	☐	☐	☐	☐	☐
Warranty tests	☐	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads	Griptester/SCRIM	☐	☐	☒	☐	Some Local Authorities measure with GripTester but convert to SCRIM equivalents for reporting
Tertiary roads	Griptester/SCRIM	☐	☐	☒	☐	as above
Urban roads		☐	☐	☐	☐	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Annual comparison trials
Device 2	unique device for research use only
Device 3	no formal national comparisons or checks
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?

☒ As a stand-alone measurement
☐ Only in combination with an outflow meter
☐ Others:
(Leave it empty, if you do not use the pendulum test)

☐ For routine monitoring or Pavement Management
☐ For acceptance or warranty tests
☒ Others: local investigations only on some local authority roads or independent accident investigators
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☒	☒	☒	☐	☐
Accident cluster analysis	☐	☐	☒	☒	☒
Response to individual crashes, e.g. police request	☐	☒	☒	☒	☒
Other					

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	Annually	Annually	Annually		
Time of year	May-September	May-September	May-September		

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	Surveys are planned so that in successive years each road length is tested in the early, middle and late parts of the testing season, the current year's data is corrected using the average skid resistance over recent years.
Primary roads	as above
Secondary roads	as above or by comparison with local benchmark sites
Tertiary roads	as above or by comparison with local benchmark sites
Urban roads	

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☐ On every lane
☒ On the first lane only
☐ On the emergency lane
☒ On ramps or link roads
☐ Other where:</td><td colspan="2">☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☒</td><td>☐</td><td></td></tr>
<tr><td>Secondary roads</td><td>☒</td><td>☐</td><td>policies vary from fully following HD28/04 to making no resistance measurements</td></tr>
<tr><td>Tertiary roads</td><td>☒</td><td>☐</td><td>policies vary from fully following HD28/04 to making no resistance measurements</td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td></td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4"></td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☒ Policies, regulations or standards… *please specify name / number of document:* HD28/04 for Highways Agency routes. Local Authorities have their own individual documents, although may refer to HD28	☐ For motorways ☒ For primary roads ☒ For secondary roads ☒ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☒	☒	☒	☒	☒
Based on another standard in this country	☐	☐	☒	☒	☒
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☐	☐	☐	☐	☐
Other			Local authorities may have carried out their own accident risk analysis or used thresholds from HA a similar		

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	Very good	good	average	poor	very poor			
Motorways	>0.45	0.40	0.35	0.30	<0.30			
Primary roads	>(0.65 - 0.45)	0.60 - 0.40	0.40 - 0.50	0.30 - 0.45	<(0.30 - 0.45)			
Secondary roads	>(0.65 -	0.60 - 0.40	0.40 - 0.50	0.30 - 0.45	<(0.30 -			

	0.45)				0.45)			
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: Note that the threshold is usually based on an index value "Characteristic SCRIM Coefficient" which has been adjusted for various factors, not a direct mu measurement from the device. Primary and Secondary roads contain different site categories and threshold levels vary between highway authorities

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☒ Improvement of skid resistance ☐ Speed limits ☒ Warning signs ☐ Reconstruction of the road ☒ Accident analysis ☒ Other measures *(please fill in)*: Full site investigation is carried out to assess whether improvement is needed. Warning signs are used only where treatment is needed by likely to be delayed ☐ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☐ Yes, the limit is °C (surface temp.) / 5°C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☒ At junctions: μ = 0.45-0.55 ☒ Before pedestrian crossings: μ = 0.50-0.55 ☒ At schools, kindergartens, etc.: μ = 0.50-0.55 ☐ Other where: T *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE		
6.1 Are acceptance tests required for newly built roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
6.2 Where are your acceptance tests based on?	☐ Policies, regulations or standards… *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	*(Use this space to comment))*
6.3 When have the acceptance tests to be taken?	☐ Before road opening ☐ After road opening *(please fill in a time span)*:	
6.4 How many runs are taken for an acceptance test measurement?	☐ One measurement per acceptance test ☐ Two measurements per acceptance test ☐ More *(please comment)*:	
6.5 Which measures are taken until the acceptance limits are verified?	☐ Speed limits ☐ Warning signs ☐ Other measures *(please fill in)*: ☐ None	
6.6 What values have to be reached in the acceptance tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	

6.7 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☐ None *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE		
7.1 Are warranty tests required to check the skid resistance of roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☐ Policies, regulations or standards *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts	*(Use this space to comment))*
7.3 How long is the warranty period?	*(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in):* ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

QUESTIONNAIRE TO GATHER INFORMATION RELATING TO SKID RESISTANCE POLICIES IN DIFFERENT COUNTRIES

The following questionnaire is used to collect information about your policies on skid resistance. Based on that information, recommendations for future harmonised EU policies on skid resistance can be defined.

Your country:	SPAIN
Your organisation:	DEPARTMENT IN CHARGE OF ROADS. SPANISH MINISTRY OF PUBLIC WORKS AND TRASNPORTS
Contact details *(e.g. Email, phone number,…)*:	mecastillo@fomento.es +34 91 597 53 29

This questionnaire has been divided into sections, each starting on a different page which relate to different aspects of skid resistance policies. The sections are as follows:

SECTION 1. GENERIC DESCRIPTION OF ROAD CLASSES

Different countries have different ways of numbering and classifying roads and in the way in which their networks are built up and administered. This section provides a list of generic descriptions that should be referred to when answering questions that relate to different types of road later in this questionnaire.

Please fill in the local name of each road class, the name of the road operator and the approximate road network length.

Motorways	• High capacity roads designed to carry fast motor traffic safely • Typically dual-carriageway roads with at least two running lanes and a hard shoulder on each carriageway • Access is typically grade-separated and junctions are free-flowing • Some categories of users (pedestrians, cyclists, tractors, …) are not permitted • In many countries, a toll has to be paid for usage		
Local name in your country:	autovía (there can be some accesses not grade-separated) or autopista (all accesses are grade-separated)		
Road operator(s):	Could be state, regional or local	Network length:	State network: 8.000 km of free motorways and 2.600 km of toll motorways
Primary roads	• Major roads linking important local centres • Provide access to motorways • Available to all types of traffic • Typically single carriageway but may have sections of dual carriageway • Can have traffic lights • Usually a distinct numbering system for the whole country is used		
Local name in your country:	carreteras convencionales de primera categoría		
Road operator(s):	Could be state, regional or local	Network length:	State network: 10.000
Secondary roads	• Roads linking smaller local centres • Usually single carriageway but may have local dual carriageway sections • Provide access to primary roads • No access restrictions • Local numbering system usually not shown along the road		
Local name in your country:	carreteras convencionales de segunda categoría		
Road operator(s):	Could be regional or local	Network length:	It should be asked to the 17 spanish autonomous regions road administrations
Tertiary or minor roads	• Roads providing local networks or links between smaller towns and villages, typically in rural areas • Not usually in national classification or numbering system • May be single-track in remote areas		
Local name in your country:	carreteras convencionales de tercera categoría		
Road operator(s):	Local	Network length:	It should be asked to the 50 spanish local road administrations

<table>
<tr><td>Urban roads / Residential roads</td><td colspan="3">Roads in urban areas
Typically subject to a speed limit of 50 km/h (or equivalent) or less</td></tr>
<tr><td>Local name in your country:</td><td colspan="3">urbanas</td></tr>
<tr><td>Road operator(s):</td><td>Local council</td><td>Network length:</td><td>It should be asked to the 8.112 spanish local councils.</td></tr>
</table>

SECTION 2. OVERVIEW OF POLICY MANAGEMENT

2.1 Do road administrations set policies or standards for skid resistance in your country?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
☒ since 1975	☒ since 1975	☒ since 1975	☒ since 1975	☒ since 1975

2.2 Even if they do not have a formal policy, do they make skid resistance measurements?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
☒ since 1975	☒ since 1975	☒ since 1975	☒ since 1975	☒ since 1975

2.3 What other measures are used to control skid resistance (e.g. materials specifications)?

polished stone value for the coarse aggregate and macrotexture specificatons.

2.4 Who sets the policy or policies or standards your country?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
State, regional or local road administration	State, regional or local road administration	Regional or local road administration	Local road administration	Local council road administration

2.5 Who is responsible for administering the standards and monitoring them?

Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Ídem 2.4	Ídem 2.4	Ídem 2.4	Ídem 2.4	Ídem 2.4

2.6 What is the legal status of the standards in your country?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Legally enforce-able	☒	☒	☒	☒	☒
Represent best practice	☐	☐	☐	☐	☐
Other (please explain):					

2.7 Use this space to write down a list of references to published documents or standards relating to your skid resistance policies:

Pliego de Prescripciones Técnicas Generales para Obras de Carreteras y Puentes (PG-3), which mentions the standards:

1) NLT-336 which is based on the TRRL Laboratory Report 737 "Measurement of skidding resistance. Part I. Guide to the use of SCRIM" (1976)

2) UNE EN 13036-1

3) UNE EN 1097-8

SECTION 3. SKID RESISTANCE MEASUREMENT DEVICES

3.1 What devices are used to measure skid resistance in your country and what operating standards are used to control the measurements made with the devices?

Device names (Please fill in the names of the devices used)	Devices are based on: International standard	National standard	CEN technical specification	Other standard
Device 1: SCRIM	☐	☒	☒	
Device 2: GRIPTESTER	☒	☐	☐	It should be asked to autonomous regions and local road administrations
Device 3: PENDULUM	☒	☒	☒	
Device 4:	☐	☐	☐	
Device 5:	☐	☐	☐	

(Please tick the boxes as appropriate.)

3.2 On which road classes are the devices used?

	Device 1	Device 2	Device 3	Device 4	Device 5
Motorways	☒	☐	☐	☐	☐
Primary roads	☒	☐	☐	☐	☐
Secondary roads	☒	☒	☒	☐	☐
Tertiary roads	☒	☒	☒	☐	☐
Urban roads	☒	☒	☒	☐	☐

(Please tick the box, if the device is used on the particular road class)

3.3 What are the main uses of the measurements?

	Device 1	Device 2	Device 3	Device 4	Device 5
Support skid resistance standards	☒	☐	☐	☐	☐
Part of a condition index	☒	☒	☐	☐	☐
Local investigations	☒	☐	☒	☐	☐
Research tool	☒	☒	☐	☐	☐
Acceptance tests	☒	☒	☒	☐	☐
Warranty tests	☐	☐	☐	☐	☐

(Please tick the boxes as appropriate.)

3.4 Does your country use measurements from more than one device as equivalent values on its network(s)? If so, indicate how the results are harmonised.

Road class	Devices used	IFI	Draft EFI method	Published direct equation	Local empirical correlation	Other *(please describe briefly)*
Motorways		☐	☐	☐	☐	
Primary roads		☐	☐	☐	☐	
Secondary roads		☐	☐	☒	☒	
Tertiary roads		☐	☐	☒	☒	
Urban roads		☐	☐	☒	☒	

(Please fill in the devices used and tick at the appropriate method. If you only use one device, proceed to the next question.)

3.5 What arrangements are made for accreditation or approval of devices used for monitoring the networks?

Device 1	Comparison tests
Device 2	It should be asked to autonomous regions and local road administrations
Device 3	It is not used to monitor the state road network
Device 4	
Device 5	

3.6 If the pendulum test is used, to what extent?

☒ As a stand-alone measurement
☐ Only in combination with an outflow meter
☐ Others:
(Leave it empty, if you do not use the pendulum test)

☐ For routine monitoring or Pavement Management
☐ For acceptance or warranty tests
☒ Others: For sections in which it is not posible to get the test speed to use SCRIM
(Leave it empty, if you do not use the pendulum test)

3.7 Use this space to give any other comments about measurement devices:

The state network skid resistance is measured only with SCRIM, other road administrations usually use GRIPTESTER as well as SCRIM but the state administration does not admit the correlation between them that is shown in the report of JACOBS BABTIE of april 2004.

SECTION 4. MONITORING THE ROAD NETWORKS IN RELATION TO POLICIES

The questions in this section relate to measurements of skid resistance used to monitor road networks and provide data supporting the skid resistance policies summarised in Section 2.

4.1 What triggers measurements of skid resistance on the networks?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Routine monitoring required by standards / policies	☐	☒	☐	☐	☐
Accident cluster analysis	☒	☒	☐	☐	☐
Response to individual crashes, e.g. police request	☒	☒	☐	☐	☐
Other			N/A	N/A	N/A

(Please tick the most appropriate boxes for each road class)

4.2 Where routine monitoring is used, how often are the roads on your country measured and when are the measurements made?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Monitoring frequency	twice a year	twice a year			
Time of year	spring and autumn	spring and autumn			

(Describe the frequency of measurements, e.g. annually, every third year, and when the measurements are usually made e.g. May-September)

4.3 Are seasonal effects taken into account on different road classes? If yes, describe how:

	Summary of procedure followed for seasonal adjustments
Motorways	Measurements are never taken in winter serviceability. All regions are measured in the wet and hot seasons to obtain the most favorable and unfavorable values but no representative coefficient is assessed for each one.
Primary roads	Measurements are never taken in winter serviceability. All regions are measured in the wet and hot seasons to obtain the most favorable and unfavorable values but no representative coefficient is assessed for each one.
Secondary roads	N/A
Tertiary roads	N/A
Urban roads	N/A

(Please summarise what is done to deal with seasonal effects on the different road classes in your country. Please proceed to the next question if you do not deal with seasonal effects.)

<table>
<tr><td rowspan="1">4.4 Where are the systematic skid resistance measurements usually taken on motorways?</td><td colspan="2">☐ On every lane
☒ On the first lane only
☐ On the emergency lane
☐ On ramps or link roads
☐ Other where: Whenever it is needed other lanes are measured</td><td colspan="2">☒ in each direction
☐ only in one direction</td></tr>
<tr><td rowspan="6">4.5 Where are the systematic skid resistance measurements taken on non-motorways?</td><td></td><td>In each direction</td><td>Only in one direction</td><td>Comments</td></tr>
<tr><td>Primary roads</td><td>☐</td><td>☒</td><td>Sistematically it is measured only in one direction but whenever it is necessary it is measured in both directions.</td></tr>
<tr><td>Secondary roads</td><td>☐</td><td>☐</td><td>N/A</td></tr>
<tr><td>Tertiary roads</td><td>☐</td><td>☐</td><td>N/A</td></tr>
<tr><td>Urban roads</td><td>☐</td><td>☐</td><td>N/A</td></tr>
<tr><td colspan="4">(Please mark a cross for each road class to specify where it is measured)</td></tr>
<tr><td>4.6 Are there any other points about monitoring practice not covered here?</td><td colspan="4">Only the right wheelpath is measured. In order to get images of the pavement, the device only measures with daylight. All devices should measure at 50 km/h to avoid speed correction on the values obtained. In the south and in the coast of Spain, only emergency measures should be taken in summertime because of traffic and water restrictions.</td></tr>
</table>

SECTION 5. THRESHOLDS AND STANDARDS

5.1 Where are your thresholds based on?	☐ Policies, regulations or standards… *please specify name / number of document:*	☒ For motorways ☒ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts…	The thresholds for routine monitoring vary depending on maintainance criteria. *(Use this space to comment))*

5.2 How have the different threshold levels been determined?

	Motorways	Primary roads	Secondary roads	Tertiary roads	Urban roads
Analysis of accident risk for the network	☒	☒	☐	☐	☐
Based on another standard in this country	☐	☐	☐	☐	☐
Based on a standard used in another country *(state which country)*					
Theoretical analysis, e.g. of stopping distances or lateral acceleration	☐	☐	☐	☐	☐
Road design parameters	☐	☐	☐	☐	☐
Based on statistics (e.g. cumulative frequencies)	☒	☒	☐	☐	☐
Other			N/A	N/A	N/A

(Tick the most appropriate box(es) for each road class)

5.3 What are the skid resistance thresholds for routine monitoring? Please indicate the different threshold levels per road class and name the threshold levels (e.g. very good, good, average, ...) as used in your country:

Levels:	excellent	extremely good	very good	good	average	bad	very bad	extremely bad
Motorways	>65	60-65	55-60	50-55	45-50	40-45	35-40	<35
Primary roads	>65	60-65	55-60	50-55	45-50	40-45	35-40	<35
Secondary roads								
Tertiary roads								
Urban roads								

(Fill in the limit value, e.g. the friction coefficient μ for each road class, if available)

Comments: These values correspond to the SFC measured by the SCRIM and are the ones applicable in 2008.

5.4 Based on policies, which measures have to be taken, if the values are worse than warning level?	☐ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☒ None
5.5 Based on policies, which measures have to be taken, if the values are worse than threshold level?	☒ Improvement of skid resistance ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Accident analysis ☐ Other measures *(please fill in)*: ☐ None
5.6 In winter, what is the minimal friction coefficient for winter roads?	μ = *(Please fill in the friction coefficient value μ to be reached)* *(Leave it empty, if skid resistance is not measured at winter conditions)*
5.7 In summer, do you have a maximum temperature limit for valid skid resistance measurements?	☒ Yes, the limit is 45°C (surface temp.) / °C (air temp.) ☐ No
5.8 Do you have special demands on skid resistance in the urban areas?	☐ At junctions: μ = ☐ Before pedestrian crossings: μ = ☐ At schools, kindergartens, etc.: μ = ☐ Other where: N/A *(Please fill in the friction coefficient value μ to be reached, if available)*
5.9 Are there any other comments regarding thresholds?	

<table>
<tr><th colspan="3">SECTION 6. POLICIES FOR ACCEPTANCE TESTS ON SKID RESISTANCE</th></tr>
<tr><td rowspan="2">6.1 Are acceptance tests required for newly built roads?</td><td>☒ Yes, …</td><td>☒ On motorways, since (please fill in a year date): 1975
☒ On primary roads, since (please fill in a year date): 1975
☐ On secondary roads, since (please fill in a year date):
☐ On tertiary roads, since (please fill in a year date):
☐ On urban roads, since (please fill in a year date):</td></tr>
<tr><td colspan="2">☐ No
(If no, please proceed to the next section)</td></tr>
<tr><td rowspan="2">6.2 Where are your acceptance tests based on?</td><td>☒ Policies, regulations or standards…
please specify name / number of document:
PG-3</td><td>☐ For motorways
☐ For primary roads
☐ For secondary roads
☐ For tertiary roads
☐ For urban roads</td></tr>
<tr><td>☐ Building plans/contracts…</td><td>(Use this space to comment))</td></tr>
<tr><td>6.3 When have the acceptance tests to be taken?</td><td colspan="2">☐ Before road opening
☒ After road opening (please fill in a time span): 2 months</td></tr>
<tr><td>6.4 How many runs are taken for an acceptance test measurement?</td><td colspan="2">☒ One measurement per acceptance test
☐ Two measurements per acceptance test
☐ More (please comment):</td></tr>
<tr><td>6.5 Which measures are taken until the acceptance limits are verified?</td><td colspan="2">☐ Speed limits
☐ Warning signs
☐ Other measures (please fill in):
☒ None</td></tr>
<tr><td>6.6 What values have to be reached in the acceptance tests?</td><td colspan="2">On motorways: μ = 60-65 (SFC values) depending on the type of asphalt mixture
On primary roads: μ = 60-65 (SFC values) depending on the type of asphalt mixture
On secondary roads: μ =
On tertiary roads: μ =
On urban roads: μ =
(Please fill in the friction coefficient μ to be reached for each road class, if available)</td></tr>
</table>

6.7 Which measures are taken, if the values are below the limits?	☒ Improvement of the skid resistance ☐ Money deduction (as long as μ ≥) ☐ Speed limits ☐ Warning signs ☒ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None
6.8 Which measures are taken to increase the early life skid resistance?	☐ None Road cleaning machines to eliminate the bituminous layer that covers the aggregates. *(Please fill in the measures used)*
6.9 Any other comments regarding acceptance test measurements:	2 months is the time span minimun to measure skid resistance

SECTION 7. POLICIES FOR WARRANTY TESTS ON SKID RESISTANCE

7.1 Are warranty tests required to check the skid resistance of roads?	☐ Yes, …	☐ On motorways, since *(please fill in a year date)*: ☐ On primary roads, since *(please fill in a year date)*: ☐ On secondary roads, since *(please fill in a year date)*: ☐ On tertiary roads, since *(please fill in a year date)*: ☐ On urban roads, since *(please fill in a year date)*:
	☒ No *(If no, please proceed to the next section)*	
7.2 Where are your warranty tests based on?	☐ Policies, regulations or standards *please specify name / number of document:*	☐ For motorways ☐ For primary roads ☐ For secondary roads ☐ For tertiary roads ☐ For urban roads
	☐ Building plans/contracts	They are based on the comparison between devices *(Use this space to comment))*
7.3 How long is the warranty period?	*(Please fill in a time span, e.g. 5 years)*	
7.4 How many runs are taken for a warranty test measurement?	☐ One measurement per warranty test ☐ Two measurements per warranty test ☐ More *(please comment)*:	
7.5 What values have to be reached in the warranty tests?	On motorways: μ = On primary roads: μ = On secondary roads: μ = On tertiary roads: μ = On urban roads: μ = *(Please fill in the friction coefficient μ to be reached for each road class, if available)*	
7.6 Which measures are taken, if the values are below the limits?	☐ Improvement of the skid resistance ☐ Money deduction (as long as μ >=) ☐ Speed limits ☐ Warning signs ☐ Reconstruction of the road ☐ Other measures *(please fill in)*: ☐ None	
7.7 Any other comments regarding warranty test measurements:		

Thank you for completing this questionnaire!

The TYROSAFE Project Consortium

TYROSAFE - AUSTRIA

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

1- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

❒ **Yes, in the high level network**

* If yes, what is the reference indicator? **LAeq**

* What are the legal thresholds? **60 dB day (6:00 – 22:00) / 50 dB night (22:00 – 6:00)**

* Is it checked?

By calculations

❒ **Yes, according to RVS 04.02.11**

By measurements

❒ **yes, only for calibration and verification of calculations**

* When is it checked?

On a project basis (for each road construction project)

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

Sound pressure level measurement by national standard ÖNORM S 5004

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❒ Tyre noise - **NO**
- ❒ Road surface noise performance **– YES (approval testing)**
- ❒ Noise barriers construction – **YES (RVS 04.02.11)**
- ❒ Speed limits for noise reduction - **NO**
- ❒ Other actions of traffic management (rerouting, night diversion, urban equipments…) – **YES (truck traffic restrictions)**
- ❒ Others (indicate) **Low-noise truck designation**

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC): **NO**

- ❒ Yes, active (mention since when)
- ❒ Under consideration

* Is it
    - ❒ A legal scheme
    - ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
    - ❒ Yes
    - ❒ No (mention the exclusions)

* Does it concern?
    - ❒ new tyres
    - ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
- ❒ **Yes, partially (Concrete: RVS 08.17.02, Asphalt: RVS 08.16.01)**
- ❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

LMA value measured according to RVS 11.06.64

EACC 8mm max. chipping size (MCS): 101 dB @ 100 km/h, 90 dB @ 50 km/h

EACC 11 mm (MCS): 102 dB @ 100 km/h

SMA S3, BBTM, Porous Asphalt: 100 dB @ 100 km/h, 96 dB @ 80 km/h, 87 dB @ 50 km/h

* What is (are) the reference speed (s)?

50, 80, 100 km/h

* What is the measurement procedure (standard, technical specification…)?

RVS 11.06.64 (trailer test)

5 - Is there a national labelling procedure for noise performances of available road surfaces?
- ❒ Yes, active (mention since when)
- ❒ **Not yet but under consideration**
- ❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?
- ❒ Never
- ❒ Always
- ❒ **Sometimes (for low noise pavements for instance)**

* If noise performances are specified, how long must they be guarantied?

Immediately after construction

* Is there a procedure for the acoustic check of Conformity of Production?
- ❒ **Yes at national level (mention since when) since 1990s**
- ❒ Yes but only at local level (mention since when)
- ❒ Not yet but under consideration
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?
- ❒ Occasionally (specify the rough percentage of cases)
- ❒ **Systematically**

* What is the measurement procedure based on (reference standards, technical specification…)? **National technical Spec (RVS 11.06.64)**

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…) **all along the section**

* What is (are) the reference speed (s)? **50, 80 100 km/h**

* When are the measurement performed?
- ❒ **Once after the work completion (specify at what age of the road surface) 1-2 months**
- ❒ Regularly (specify)

* What is the tolerance on noise levels? **1 dB**

* Which measures are taken if the measured noise levels are above the requirement?
- ❒ Rebuilt of the section
- ❒ **Financial penalty**
- ❒ None
- ❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❒ **Never**
- ❒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ❒ Others

* Is there a national procedure for this acoustic monitoring?

- ❒ **No (*go to question 8*)**
- ❒ Not yet but under consideration
- ❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?

- ❒ public data base
- ❒ Road manager’s own data base
- ❒ Road surface replacement
- ❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements’ rolling resistance in your country?

- ❒ Yes
- ❒ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO_2-emissions by using road surfaces with low rolling resistance?

- ❒ Yes
- ❒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

- ❒ Yes
- ❒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

- ❐ Yes
- ❐ No (*end of questionnaire*)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

13 – Which measurement procedure do you use?

TYROSAFE BELGIUM

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

1- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ☐ yes
- ☒ no (*go to question 2*)

* If yes, what is the reference indicator?

* What are the legal thresholds?

* Is it checked?

By calculations

- ☐ yes (indicate the reference calculation method)
- ☐ no

By measurements

- ☐ yes
- ☐ no

* When is it checked?

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others...)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ☐ Tyre noise
- ☐ Road surface noise performance
- ☒ Noise barriers construction in Flanders region
- ☐ Speed limits for noise reduction
- ☐ Other actions of traffic management (rerouting, night diversion, urban equipments...)
- ☐ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ☐ Yes, active (mention since when)
- ☐ Under consideration
- ☒ no

* Is it
  - [ ] A legal scheme
  - [ ] A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
  - [ ] Yes
  - [ ] No (mention the exclusions)

* Does it concern?
  - [ ] new tyres
  - [ ] retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
  - [ ] Yes
  - [x] No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

5 - Is there a national labelling procedure for noise performances of available road surfaces?
  - [ ] Yes, active (mention since when)
  - [ ] Not yet but under consideration
  - [x] No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?

- [ ] Never
- [ ] Always
- [x] Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied?

only initial noise performance e.g. "the road surface must not be more noisy than standard DAC"

* Is there a procedure for the acoustic check of Conformity of Production?

- [ ] Yes at national level (mention since when)
- [ ] Yes but only at local level (mention since when)
- [ ] Not yet but under consideration
- [x] No and not interested (*go to question 7*)

* Is this procedure applied?

- [ ] Occasionally (specify the rough percentage of cases)
- [ ] Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?

- [ ] Once after the work completion (specify at what age of the road surface)
- [ ] Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?

- [ ] Rebuilt of the section
- [ ] Financial penalty
- [ ] None
- [ ] Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- [x] Never
- [ ] On some networks, depending on the network manager
- [ ] Yes, systematically
- [ ] Others

* Is there a national procedure for this acoustic monitoring?

- [x] No (*go to question 8*)
- [ ] Not yet but under consideration
- [ ] Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?
  - ☐ public data base
  - ☐ Road manager's own data base
  - ☐ Road surface replacement
  - ☐ Others

BELGIUM (L.Goubert, CRR)

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?
  - ☐ Yes
  - ☒ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?
  - ☐ Yes
  - ☒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?
  - ☒ Yes, of course
  - ☐ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?
  - ☒ Yes
  - ☐ No (*end of questionnaire*)

currently
→ under restauration

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

rolling resistance trailer

13 – Which measurement procedure do you use?

not specified yet

TYROSAFE - BULGARIA

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

2- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

❒ yes
☒ no (*go to question 2*)

* If yes, what is the reference indicator?

* What are the legal thresholds?

* Is it checked?

By calculations
❒ yes (indicate the reference calculation method)
❒ no

By measurements
❒ yes
❒ no

* When is it checked?

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

❒ Tyre noise
❒ Road surface noise performance
☒ Noise barriers construction
☒ Speed limits for noise reduction
❒ Other actions of traffic management (rerouting, night diversion, urban equipments…)
❒ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

❒ Yes, active (mention since when)
❒ Under consideration

* Is it
  - ❒ A legal scheme
  - ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
  - ❒ Yes
  - ❒ No (mention the exclusions)

* Does it concern?
  - ❒ new tyres
  - ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
  - ❒ Yes
  - ☒No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

5 - Is there a national labelling procedure for noise performances of available road surfaces?
  - ❒ Yes, active (mention since when)
  - ❒Not yet but under consideration
  - ☒No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?

- ❒ Never
- ☒ Always
- ❒ Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied?

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ Yes at national level (mention since when)
- ❒ Yes but only at local level (mention since when)
- ☒ Not yet but under consideration
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (<u>reference standards</u>, technical specification…)?

* Where are the measurements performed? (Random spot(s), <u>all along the section</u>, at façades of buildings…)

* What is (are) the reference speed (s)? – V_{85}

* When are the measurement performed?

- ☒ Once after the work completion (specify at what age of the road surface)- 6 mounths
- ❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?

- ❒ Rebuilt of the section
- ❒ Financial penalty
- ❒ None
- ☒ Others (specify) – Construction of noise reducing barriers.

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❒ Never
- ❒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ☒ Others /Under request for some road networks only/

* Is there a national procedure for this acoustic monitoring?

- ☒ No (*go to question 8*)
- ❒ Not yet but under consideration
- ❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?

- ❒ public data base
- ❒ Road manager's own data base
- ❒ Road surface replacement
- ❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

- ❒ Yes
- ☒ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?

- ❒ Yes
- ☒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

- ❒ Yes
- ☒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

- ☒ Yes
- ❒ No (*end of questionnaire*)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?
SRT measurement pendulum (Friction measurement equipment in process of delivering by sealed bidding procedure). The owner is National Road Infrastructure Agency.

13 – Which measurement procedure do you use? According to EN Standards

TYROSAFE – CZECK REPUBLIC

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

3- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ❒ Yes. Exactly regarding road traffic noise immission.
- ❒ no (*go to question 2*)

* If yes, what is the reference indicator? LAeq

* What are the legal thresholds?

New built-up areas: for day-time LAeq = 60 dB, for night-time LAeq = 50 dB

* Is it checked?

By calculations

- ❒ yes (indicate the reference calculation method) Relevant national and international calculation methods are being applied.
- ❒ no

By measurements

- ❒ yes
- ❒ no

* When is it checked? New planned roads, health reasons, etc.

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

Measurement procedure respect ISO 1996-1,2 and Guide issued by Ministry of Health of the Czech Republic.

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❒ Tyre noise
- ❒ Road surface noise performance
- ❒ Noise barriers construction
- ❒ Speed limits for noise reduction
- ❒ Other actions of traffic management (rerouting, night diversion, urban equipments…)
- ❒ Others (indicate) The choice and application of road traffic noise reduction measures respect the particular physical situation, economic effectiveness, etc.

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ❒ Yes, active (mention since when)
- ❒ Under consideration
- ❒ No

* Is it

- ❒ A legal scheme
- ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?

- ❒ Yes
- ❒ No (mention the exclusions)

* Does it concern?

- ❒ new tyres
- ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?

- ❒ Yes
- ❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

5 - Is there a national labelling procedure for noise performances of available road surfaces?

- ❒ Yes, active (mention since when)
- ❒ Not yet but under consideration
- ❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?

- ❒ Never
- ❒ Always
- ❒ Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied?

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ Yes at national level (mention since when)
- ❒ Yes but only at local level (mention since when)
- ❒ Not yet but under consideration
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?

- ❒ Once after the work completion (specify at what age of the road surface)
- ❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?

- ❒ Rebuilt of the section
- ❒ Financial penalty
- ❒ None
- ❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❒ Never
- ❒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ❒ Others

* Is there a national procedure for this acoustic monitoring?

- ❒ No (*go to question 8*)
- ❒ Not yet but under consideration
- ❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?
- ❒ public data base
- ❒ Road manager's own data base
- ❒ Road surface replacement
- ❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?
- ❒ Yes
- ❒ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?
- ❒ Yes
- ❒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?
- ❒ Yes
- ❒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?
- ❒ Yes
- ❒ No (*end of questionnaire*)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

13 – Which measurement procedure do you use?

TYROSAFE - FINLAND

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

4- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

❒ yes
X no (*go to question 2*)

* If yes, what is the reference indicator?

* What are the legal thresholds?

* Is it checked?

By calculations
❒ yes (indicate the reference calculation method)
❒ no

By measurements
❒ yes
❒ no

* When is it checked?

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

❒ Tyre noise
❒ Road surface noise performance
❒ Noise barriers construction
❒ Speed limits for noise reduction
❒ Other actions of traffic management (rerouting, night diversion, urban equipments…)
❒ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

❒ Yes, active (mention since when)
❒ Under consideration

* Is it

❒ A legal scheme
❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
❒ Yes
❒ No (mention the exclusions)

* Does it concern?
❒ new tyres
❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
X Yes
❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

- National specified CPX value 89,0 dB

* What is (are) the reference speed (s)?

50 km/h

* What is the measurement procedure (standard, technical specification…)?
National method description PANK 5210 (includes some modifications compared to ISO/CD 11819-2) http://www.pank.fi/files/363_PANK5210_CPX_2008.pdf

5 - Is there a national labelling procedure for noise performances of available road surfaces?
❒ Yes, active (mention since when)
X Not yet but under consideration by a working group
❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

National specified CPX value

* What is (are) the reference speed (s)?

50 km/h

* What is the measurement procedure (standard, technical specification…)?
National method description PANK 5210 (includes some modifications compared to ISO/CD 11819-2) http://www.pank.fi/files/363_PANK5210_CPX_2008.pdf

* How many worksites are necessary for obtaining the label?

3 during the last 3 years

* How is the site-to-site variation addressed?

Not defined yet

* How many labels have been delivered up to now?

Not possible yet

* How many independent measurement organisations have been involved in this labelling?

Not defined yet

6 – Are road noise performances specified in tendering procedures?

- ❒ Never
- ❒ Always
- **X Sometimes when the low noise pavement is wanted**

* If noise performances are specified, how long must they be guarantied?

One year. CPX value 89,0 after a year is a quality requirement. The measurement is done by CPX according to:

http://www.pank.fi/files/363_PANK5210_CPX_2008.pdf

Speed 50 km/h.

The quality requirement is used when the low noise pavement is decided to use in the site. The Road regions and Cities make decisions.

The CPX measurement is not needed if the low noise pavement is defined by Client, for example SMA 5. If the measurement is required after a year, the contractors can provide their own products. At the same time, there is a requirement for resistance to abrasion caused by studded tyres. These two requirements are opposed to each other, so the low noise pavement is always a compromise on main roads in Finland when the driving speed is over 80 km/h. (A good resistance to abrasion caused by studded tyres requires bigger aggregate sizes which are noisy)

Measured value 88,0 - 90,0 Is OK.

Measured value ≤ 87,5 causes bonus

Measured value ≥ 90,5 causes penalty

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❒ Never
- ❒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ❒ Others

* Is there a national procedure for this acoustic monitoring?

X No (*go to question 8*)
❒ Not yet but under consideration
❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?

❒ public data base
❒ Road manager's own data base
❒ Road surface replacement
❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

❒ Yes
X No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?

X Yes
❒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

X Yes,
❒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

❒ Yes
X No (*end of questionnaire*), not ongoing but pre-studies "state of art" have been done.

TYROSAFE - FRANCE

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

5- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

☒yes
❒ no (*go to question 2*)

* If yes, what is the reference indicator? LAeq[6h-22h] and LAeq[22h-6h]

* What are the legal thresholds? 60 dB(A) and 55 dB(A) (depending on area and night/day period)

* Is it checked?

By calculations
☒ yes : before road construction or significant modification
☒ no : no check by calculation after the construction

By measurements
☒ yes
❒ no

* When is it checked? After road construction

* If checked by measurements, what is the measurement procedure (international standard, ~~national standard, technical specification, others~~…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

❒ Tyre noise
❒ Road surface noise performance
❒ Noise barriers construction
❒ Speed limits for noise reduction
❒ Other actions of traffic management (rerouting, night diversion, urban equipments…)
❒ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

❒ Yes, active (mention since when)

❒ Under consideration
☒ no

* Is it
  ❒ A legal scheme
  ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
  ❒ Yes
  ❒ No (mention the exclusions)

* Does it concern?
  ❒ new tyres
  ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
  ☒ Yes
  ❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ? SPB level 76 dB(A)

* What is (are) the reference speed (s)? 90 km/h

* What is the measurement procedure (standard, technical specification…)? SPB ISO 11819-1

5 - Is there a national labelling procedure for noise performances of available road surfaces?
  ❒ Yes, active (mention since when)
  ☒ Not yet but under consideration
  ❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)? SPB level for passenger cars at 90 km/h

* What is (are) the reference speed (s)? 90 km/h

* What is the measurement procedure (standard, technical specification…)? SPB ISO 11819-1

* How many worksites are necessary for obtaining the label? 2 at least

* How is the site-to-site variation addressed? Average on 2 sites (or more)

* How many labels have been delivered up to now? 0

* How many independent measurement organisations have been involved in this labelling? 5

6 – Are road noise performances specified in tendering procedures?

- ❒ Never
- ❒ Always
- ☒ Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied? At initial state (after 2 or 3 months)

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ Yes at national level (mention since when)
- ❒ Yes but only at local level (mention since when)
- ☒ Not yet but under consideration
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)? CPX national standard

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…) along the section

* What is (are) the reference speed (s)? the posted speed

* When are the measurement performed?

- ☒ Once after the work completion (specify at what age of the road surface)
- ❒ Regularly (specify)

* What is the tolerance on noise levels? 2dB(A)

* Which measures are taken if the measured noise levels are above the requirement?

- ❒ Rebuilt of the section
- ❒ Financial penalty
- ❒ None
- ☒ Others (specify) do not know yet !

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❒ Never
- ☒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ❒ Others

* Is there a national procedure for this acoustic monitoring?

- ❒ No (*go to question 8*)

☒ Not yet but under consideration
❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)? CPX national standard

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…) all along the networks

* How often are the measurements performed? Once a year

* Can different measurement organisation be involved for a same road section? Not at the moment

* What is the main use of acoustic monitoring?
❒ public data base
☒ Road manager’s own data base
❒ Road surface replacement
❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements’ rolling resistance in your country?
❒ Yes
☒ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?
❒ Yes
☒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?
❒ Yes
❒ No
☒ Do not know

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?
❒ Yes
☒ No (*end of questionnaire*)

TYROSAFE - GERMANY
Questionnaire on noise emission

Working document

1 Topics of survey on noise emission

6- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC) ?

- ❐ yes
- ❐ no (*go to question 2*)

* If yes, what is the reference indicator? $L_{r,day}$, $L_{r,night}$

* What are the legal thresholds? day: 57; night: 47 / d 59; n 49 / d 64; n 54 / d 69; n 59 dB(A)

* Is it checked?

By calculations

- ❐ yes (indicate the reference calculation method) RLS-90
- ❐ no

By measurements

- ❐ yes
- ❐ no

* When is it checked? Before building of road

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❐ Tyre noise
- ❐ Road surface noise performance
- ❐ Noise barriers construction
- ❐ Speed limits for noise reduction
- ❐ Other actions of traffic management (rerouting, night diversion, urban equipments…)
- ❐ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ❐ Yes, active (mention since when)
- ❐ Under consideration

* Is it
- ❒ A legal scheme
- ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
- ❒ Yes
- ❒ No (mention the exclusions)

* Does it concern?
- ❒ new tyres
- ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
- ❒ Yes
- ❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ? L_{AFmax} 85,2 dB(A)

* What is (are) the reference speed (s)? PC @ 120 km/h

* What is the measurement procedure (standard, technical specification…)?
CPB GEStro-92 / SPB ISO11819-1

5 - Is there a national labelling procedure for noise performances of available road surfaces?
- ❒ Yes, active (mention since when) 1981
- ❒ Not yet but under consideration
- ❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)? $L_m^{(25)}$ “nicht geriffelter Gussasphalt”

* What is (are) the reference speed (s)? PC @ 120 km/h

* What is the measurement procedure (standard, technical specification…)? CPB GEStro-92 /SPB ISO11819-3

* How many worksites are necessary for obtaining the label? 5 min.

* How is the site-to-site variation addressed? not considered

* How many labels have been delivered up to now? 10

* How many independent measurement organisations have been involved in this labelling? 2

6 – Are road noise performances specified in tendering procedures?

- ❒ Never
- ❒ Always
- ❒ Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied? 5 years

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ Yes at national level (mention since when)
- ❒ Yes but only at local level (mention since when)
- ❒ Not yet but under consideration
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?

- ❒ Once after the work completion (specify at what age of the road surface)
- ❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?

- ❒ Rebuilt of the section
- ❒ Financial penalty
- ❒ None
- ❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❒ Never
- ❒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ❒ Others sometimes if specified in tendering procedure

* Is there a national procedure for this acoustic monitoring?

- ❒ No (*end of questionnaire*)
- ❒ Not yet but under consideration
- ❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)? CPB GEStro-92 / SPB ISO11819-1

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…) single spot

* How often are the measurements performed? once a year or less frequent

* Can different measurement organisation be involved for a same road section? yes

* What is the main use of acoustic monitoring?
- ❐ public data base
- ❐ Road manager's own data base
- ❐ Road surface replacement
- ❐ Others

TYROSAFE - LATVIA

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

7- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ❐ yes
- x no (*go to question 2*)

* If yes, what is the reference indicator?

* What are the legal thresholds?

* Is it checked?

By calculations

- ❐ yes (indicate the reference calculation method)
- ❐ no

By measurements

- ❐ yes
- ❐ no

* When is it checked?

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❐ Tyre noise
- ❐ Road surface noise performance
- ❐ Noise barriers construction
- ❐ Speed limits for noise reduction
- ❐ Other actions of traffic management (rerouting, night diversion, urban equipments…)
- ❐ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ❐ Yes, active (mention since when)
- ❐ Under consideration

* Is it
  - ❒ A legal scheme
  - ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
  - ❒ Yes
  - ❒ No (mention the exclusions)

* Does it concern?
  - ❒ new tyres
  - ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
  - ❒ Yes
  - x No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

5 - Is there a national labelling procedure for noise performances of available road surfaces?
  - ❒ Yes, active (mention since when)
  - ❒ Not yet but under consideration
  - x No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?
- x Never
- ❒ Always
- ❒ Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied?

* Is there a procedure for the acoustic check of Conformity of Production?
- ❒ Yes at national level (mention since when)
- ❒ Yes but only at local level (mention since when)
- ❒ Not yet but under consideration
- x No and not interested (*go to question 7*)

* Is this procedure applied?
- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?
- ❒ Once after the work completion (specify at what age of the road surface)
- ❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?
- ❒ Rebuilt of the section
- ❒ Financial penalty
- ❒ None
- ❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?
- x Never
- ❒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ❒ Others

* Is there a national procedure for this acoustic monitoring?
- x No (*go to question 8*)
- ❒ Not yet but under consideration
- ❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?
- ❒ public data base
- ❒ Road manager's own data base
- ❒ Road surface replacement
- ❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?
- ❒ Yes
- x No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?
- ❒ Yes
- x No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?
- x Yes
- ❒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?
- ❒ Yes
- x No (*end of questionnaire*)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

13 – Which measurement procedure do you use?

TYROSAFE - NETHERLANDS

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

8- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ❒ Yes
- ❒ no (*go to question 2*)

* If yes, what is the reference indicator? Lden

* What are the legal thresholds? Dependant on situation 48 – 68 dB

* Is it checked?

By calculations

- ❒ yes (reference calculation method) SRM wegverkeerslawaai
- ❒ no

By measurements

- ❒ yes
- ❒ no

* When is it checked? When planning new roads or before large reconstruction of existing road

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❒ Tyre noise – through EU limits
- ❒ Road surface noise performance - application of PA and TLPA on HWN, and TSL on lower/urban roads
- ❒ Noise barriers construction - if needed
- ❒ Speed limits for noise reduction - no
- ❒ Other actions of traffic management (rerouting, night diversion, urban equipments…) - no
- ❒ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ❒ Yes, active (IPG stimulation of low noise tyres)
- ❒ Under consideration

* Is it
- ❒ A legal scheme
- ❒ A stimulation scheme - commitment of Profile Tyre Centre

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
- ❒ Yes
- ❒ No (mention the exclusions) includes only passenger car tyres

* Does it concern?
- ❒ new tyres
- ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market? unknown

* What is the reference indicator? EU noise limits

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes? More than 4 dB reduction compared to tyre-noise limit

* Is there an estimation of the benefit in terms of traffic noise reduction? Estimated 2 dB on the long term

4 – Is there a (national) definition for low noise road surfaces?
- ❒ Yes
- ❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

Reference road surface for Noise emission is DAC 0/16

method Cwegdek is based on SPB levels measured on “new” surfaces

thus in the method a low noise DAC is new reference.

No limits

* What is (are) the reference speed (s)?

depends on type of road 50 / 80 / 110 km

passenger cars 80 km / HV’s 70 km

* What is the measurement procedure (standard, technical specification…)?
ISO 11819-1 ; SPB levels at 5m measurement height
ISO 11819-2; CPX

5 - Is there a national labelling procedure for noise performances of available road surfaces?

- ❒ Yes, active (method Cwegdek since 1999)
- ❒ Not yet but under consideration
- ❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label? 5 works

* How is the site-to-site variation addressed? Average value is calculated when results of 5 works are within 2 dB range

* How many labels have been delivered up to now?

Around 34 proprietary products, mainly TSL, and 13 pavement types, see the spreadsheet

http://www.stillerverkeer.nl/index.php?section=rmv&page=actuelelijst

* How many independent measurement organisations have been involved in this labelling?

3 companies M+P, DGMR, van Keulen

6 – Are road noise performances specified in tendering procedures?

- ❒ Never
- ❒ Always (noise is a functional requirement for low noise pavements)
- ❒ Sometimes

* If noise performances are specified, how long must they be guarantied? Usually not but sometimes noise limits are also specified 2 years after construction.

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ Yes at national level
- ❒ Yes but only at local level (since stimulation program in 2001; Productie Controle Geluid consists of combination of SPB and CPX measurements)
- ❒ Not yet but under consideration
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases) For PA 0/16 on HWN no COP is applied. For TLPA and TSL around 50% COP.
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)? SPB and CPX

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…) SPB single loc., CPX along whole section

* What is (are) the reference speed (s)? urban 50 km, higher 80 km/h

* When are the measurement performed?

- ❐ Once after the work completion (between 1 to 3 month's after completion)
- ❐ Regularly (specify) (after 2 years)

* What is the tolerance on noise levels?

COP on Contract demand includes no tolerance, this is a weak point in the PCG system. The Cwegdek label is an average value, so in COP tolerance has to be included !

In NL sometimes therefore a tolerance of 1.0 dB or 1.5 dB is included. (SILVIA proposal)

* Which measures are taken if the measured noise levels are above the requirement?

- ❐ Rebuilt of the section result >1.5 dB over demand
- ❐ Financial penalty result 1.0-1.5 dB over demand
- ❐ None
- ❐ Others (specify)

This is a big debate between asphalt contract experts and noise-experts.
So different approaches exist. Result of the stimulation program in 2001/2 was that in maybe 3 out of 190 cases a section was rebuild.
For large sections and on HWN rebuilding is not an option due to high costs and extra traffic hindrance due to the work. Then financial penalties should be applied.

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❐ Never
- ❐ On some networks, depending on the network manager
- ❐ Yes, systematically
- ❐ Others

* Is there a national procedure for this acoustic monitoring?

- ❐ No (*go to question 8*)
- ❐ Not yet but under consideration
- ❐ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?

- ❐ public data base
- ❐ Road manager's own data base
- ❐ Road surface replacement
- ❐ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

- ❐ Yes
- ❐ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?

- ❐ Yes
- ❐ No

This is a new issue that can be of importance ; old PA 0/16 shows ravelling and this can increase RR
Road authority is not interested because this will introduce tighter maintenace limits for ravelling and thus more maintenance costs.

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

- ❐ Yes
- ❐ No

There is no benefit for the road authority

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

- ❐ Yes
- ❐ No (*end of questionnaire*)

Comparison of 2 RR measurement systems of TUG and BASt and of vehicle fuel measurement has been done in IPG / SILVIA
Trailer systems showed good comparison/ fuel measurement instrumented pasenger car is not accurate enough due to external factors like wind etc.

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?
none

13 – Which measurement procedure do you use?

In situ RR measurement systems of TUG or BASt (trailer systems)

TYROSAFE - POLAND

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

9- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

❐ yes
~~❐ no (*go to question 2*)~~

* If yes, what is the reference indicator?

"Rozporządzeniu Ministra Środowiska z dnia 14 czerwca 2007 r. w sprawie dopuszczalnych poziomów hałasu w środowisku, (Dz.U. 2007, Nr 120, poz. 826)."

* What are the legal thresholds?

From 45 to 65 depending on the land use and night/day period

* Is it checked?

By calculations
❐ yes (indicate the reference calculation method)
❐ no
By measurements
❐ yes
❐ no

It may be calculated or measured

* When is it checked?

Before the road construction starts (calculations) and during noise mapping (calculations or measurements)

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

National procedure

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

~~❐ Tyre noise~~
~~❐ Road surface noise performance~~
~~❐ Noise barriers construction~~
~~❐ Speed limits for noise reduction~~

- ~~❒ Other actions of traffic management (rerouting, night diversion, urban equipments…)~~
- ~~❒ Others (indicate)~~

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ~~❒ Yes, active (mention since when)~~
- ~~❒ Under consideration~~

* Is it
  - ❒ A legal scheme
  - ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
  - ❒ Yes
  - ❒ No (mention the exclusions)

* Does it concern?
  - ❒ new tyres
  - ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?

- ~~❒ Yes~~
- ❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

We use HARMONOISE/IMAGINE but it is not official

5 - Is there a national labelling procedure for noise performances of available road surfaces?

- ~~❒ Yes, active (mention since when)~~
- ~~❒ Not yet but under consideration~~
- ❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?

- ~~❒ Never~~
- ~~❒ Always~~
- ~~❒ Sometimes (for low noise pavements for instance)~~
- ❒ *I don't think so*

* If noise performances are specified, how long must they be guarantied?

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ *Yes at national level (mention since when)*
- ❒ *Yes but only at local level (mention since when)*
- ❒ *Not yet but under consideration*
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?

- ❒ Once after the work completion (specify at what age of the road surface)
- ❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?

- ❒ Rebuilt of the section
- ❒ Financial penalty
- ❒ None
- ❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ~~❒ Never~~
- ❒ On some networks, depending on the network manager
- ~~❒ Yes, systematically~~
- ~~❒ Others~~

* Is there a national procedure for this acoustic monitoring?

- ❒ No (*go to question 8*)
- ~~❒ Not yet but under consideration~~
- ~~❒ Yes~~

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?

- ❒ public data base
- ❒ Road manager's own data base
- ❒ Road surface replacement
- ❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

- ~~❒ Yes~~
- ❒ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?

- ❒ Yes
- ~~❒ No~~

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

- ❒ Yes
- ~~❒ No~~

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

- ❐ Yes
- ~~❐ No (*end of questionnaire*)~~

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

Unique trailer for rolling resistance measurements on the road and two drum facilities to test tyre rolling resistance on replica road surfaces. All this owned by the Technical University of Gdansk

13 – Which measurement procedure do you use?
For drum measurements ISO 18164
For road measurements - TUG's Methodology

TYROSAFE - PORTUGAL

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

10- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ❐ yes
- ❐ no (*go to question 2*) No

* If yes, what is the reference indicator?

* What are the legal thresholds?

* Is it checked?

By calculations

- ❐ yes (indicate the reference calculation method)
- ❐ no

By measurements

- ❐ yes
- ❐ no

* When is it checked?

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding - No

- ❐ Tyre noise
- ❐ Road surface noise performance
- ❐ Noise barriers construction
- ❐ Speed limits for noise reduction
- ❐ Other actions of traffic management (rerouting, night diversion, urban equipments…)
- ❐ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC): No

- ❐ Yes, active (mention since when)
- ❐ Under consideration

* Is it
  - ❒ A legal scheme
  - ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
  - ❒ Yes
  - ❒ No (mention the exclusions)

* Does it concern?
  - ❒ new tyres
  - ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
  - ❒ Yes
  - ❒ No (*go to question 5*) No

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

5 - Is there a national labelling procedure for noise performances of available road surfaces?
  - ❒ Yes, active (mention since when)
  - ❒ Not yet but under consideration
  - ❒ No interest (*go to question 6*) No, but road administrations are interested in developing one

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?

- ❒ Never never
- ❒ Always
- ❒ Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied?

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ Yes at national level (mention since when)
- ❒ Yes but only at local level (mention since when)
- ❒ Not yet but under consideration
- ❒ No and not interested (*go to question 7*) No, but road administrations are interested in developing one

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?

- ❒ Once after the work completion (specify at what age of the road surface)
- ❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?

- ❒ Rebuilt of the section
- ❒ Financial penalty
- ❒ None
- ❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❒ Never
- ❒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ❒ Others Occasionally on high speed urban roads by road administrations and for research purposes

* Is there a national procedure for this acoustic monitoring?

- ❒ No (*go to question 8*) No, when necessary international standards are adopted
- ❒ Not yet but under consideration

- ❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?

- ❒ public data base
- ❒ Road manager's own data base
- ❒ Road surface replacement
- ❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

- ❒ Yes
- ❒ No (only for skid resistance, specified in tendering procedures)

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?

- ❒ Yes yes
- ❒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

- ❒ Yes yes
- ❒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

- ❒ Yes
- ❒ No (*end of questionnaire*) no (for skid resistance yes)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

TYROSAFE - SLOVAKIA

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

11- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ❒ **yes**
- ❒ no (*go to question 2*)

* If yes, what is the reference indicator?

L_{Aeq} for day, evening, night

* What are the legal thresholds?

Tab.1. The Slovakia external environment noise limits

Land category	Description of protected territory	Reference time interval	Limit values [dB]				
			Traffic noise				Noise from other sources $L_{Aeq,p}$
			Road and water transport $L_{Aeq,p}$	Electric railways $L_{Aeq,p}$	Air transport		
					$L_{Aeq,p}$	$L_{ASmax,p}$	
I.	Spa and therapeutic areas	**Day**	45	45	50	-	45
		Evening	45	45	50	-	45
		Night	40	40	40	60	40
II.	Place in front of habitable room windows, place in front of windows of protected school and health rooms, holiday resort	**Day**	**50**	50	55	-	50
		Evening	**50**	50	55	-	50
		Night	**45**	45	45	65	45
III.	The same place as the category II in environment of highways, 1st and 2nd roads, urban roads with public traffic, electric railways and airports, core city	**Day**	**60**	60	60	-	50
		Evening	**60**	60	60	-	50
		Night	**50**	55	50	75	45
IV.	Industry areas	**Day**	70	70	70	-	70
		Day	70	70	70	-	70
		Day	70	70	70	95	70

* Is it checked?

By calculations

❒ **yes** (indicate the reference calculation method)

Traffic noise – procedure for computing of noise levels from transport – 1990
Amendment of procedure for computing traffic noise from road transport – 1995
Amendment of procedure for computing traffic noise from road transport – 2005
NMPB Routes 96 according to French standard XPS 31-133 - strategic noise mapping according to *DIRECTIVE 2002/49/EC*

❒ no

By measurements

❒ **yes**

❒ no

* When is it checked?

During process EIA, following declaration of complaint

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

The procedure of Assessment of Traffic Noise Emission in Slovak Republic is defined in the Regulation of Ministry of Health of the Slovak republic No. 549/2007 Collection of Laws.

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❒ Tyre noise
- ❒ Road surface noise performance
- ❒ **Noise barriers construction**
- ❒ **Speed limits for noise reduction**
- ❒ Other actions of traffic management (rerouting, night diversion, urban equipments…)
- ❒ Others (indicate)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ❒ Yes, active (mention since when)
- ❒ Under consideration
- ❒ **No ((As civil engineering expert exactly I do not know)**

* Is it

- ❒ A legal scheme
- ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?

- ❒ Yes
- ❒ No (mention the exclusions)

* Does it concern?
  - ❒ new tyres
  - ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
  - ❒ Yes
  - ❒ **No** (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

5 - Is there a national labelling procedure for noise performances of available road surfaces?
  - ❒ Yes, active (mention since when)
  - ❒ Not yet but under consideration
  - ❒ **No interest** (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?
  - ❒ Never
  - ❒ Always
  - ❒ **Sometimes (for low noise pavements for instance)**

* If noise performances are specified, how long must they be guarantied?

* Is there a procedure for the acoustic check of Conformity of Production?
  - ❒ Yes at national level (mention since when)

❒ Yes but only at local level (mention since when)
❒ Not yet but under consideration
❒ **No and not interested** (*go to question 7*)

* Is this procedure applied?
❒ Occasionally (specify the rough percentage of cases)
❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?
❒ Once after the work completion (specify at what age of the road surface)
❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?
❒ Rebuilt of the section
❒ Financial penalty
❒ None
❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?
❒ Never
❒ **On some networks, depending on the network manager**
❒ Yes, systematically
❒ Others

* Is there a national procedure for this acoustic monitoring?
❒ **No** (*go to question 8*)
❒ Not yet but under consideration
❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?
❒ public data base
❒ Road manager's own data base
❒ Road surface replacement

- ❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

- ❒ Yes
- ❒ **No**

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?

- ❒ **Yes**
- ❒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

- ❒ **Yes (minimal influence)**
- ❒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

- ❒ Yes
- ❒ **No** (*end of questionnaire*)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

13 – Which measurement procedure do you use?

TYROSAFE - SLOVENIA

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

12- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ❖ **yes**
- ❒ no (*go to question 2*)

* If yes, what is the reference indicator?

Reference indicators are the same as in EC Directive 2002/49/EC, namely L_{day}, $L_{evening}$, L_{night}, L_{den}

* What are the legal thresholds?

Legal thresholds for the aformentioned indicators are established in the Decree on limit values of environmental noise indicators (Official Journal RS, No.105/2005)

The legal thresholds are defined for four different types of zones with different degree of envornmental protection needed (annex 1). Cricital values for different types of zones are defined for indicators L_{night} and L_{den}. Limit values for road traffic noise for different types of zones are defined for indicators L_{day}, $L_{evening}$, L_{night} and L_{den} , respectively.

* Is it checked?

By calculations

- ❖ **yes** (indicate the reference calculation method)
- ❒ no

By measurements

- ❖ **yes**
- ❒ no

* When is it checked?

Calculations before opening of the road section

Noise imission measurements after opening of the road section for traffic

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

Regulations on Initial assessment of Noise and Operational Monitoring for Sources of Noise and on Conditions for their Execution (OJ RS No. 105/2008),
Standards ISO 1996-1 and ISO 1996-2

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❒ Tyre noise
- ❖ **Road surface noise performance *(under consideration)***
- ❖ **Noise barriers construction**
- ❒ Speed limits for noise reduction
- ❒ Other actions of traffic management (rerouting, night diversion, urban equipments…)
- ❖ **Others (indicate)** ***Sound insulation of facades (especially windows)***

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ❒ Yes, active (mention since when)
- ❒ Under consideration
- ❖ **No**

* Is it

- ❒ A legal scheme
- ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?

- ❒ Yes
- ❒ No (mention the exclusions)

* Does it concern?

- ❒ new tyres
- ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?

- ❒ Yes
- ❖ **No (*go to question 5*)** ***not yet***

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

5 - Is there a national labelling procedure for noise performances of available road surfaces?

- ❒ Yes, active (mention since when)
- ❖ **Not yet but under consideration**
- ❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

* How many worksites are necessary for obtaining the label?

* How is the site-to-site variation addressed?

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?

- ❖ **Never**
- ❒ Always
- ❒ Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied?

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ Yes at national level (mention since when)
- ❒ Yes but only at local level (mention since when)
- ❖ **Not yet but under consideration**
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?

- ❒ Once after the work completion (specify at what age of the road surface)
- ❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?
  - ❒ Rebuilt of the section
  - ❒ Financial penalty
  - ❒ None
  - ❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?
  - ❒ Never
  - ❒ On some networks, depending on the network manager
  - ❒ Yes, systematically
  - ❖ **Others**

  Not the acoustic monitoring of the road surfaces only (at the moment), but the overall traffic noise imission on relevant locations (e.g. at facades) along the roads

* Is there a national procedure for this acoustic monitoring?
  - ❒ No (*go to question 8*)
  - ❒ Not yet but under consideration
  - ❖ **Yes**

* What is the measurement procedure based on (reference standards, technical specification…)?

Regulations on Initial assessment of Noise and Operational Monitoring for Sources of Noise and on Conditions for their Execution (OJ RS No. 105/2008),
Standards ISO 1996-1 and ISO 1996-2

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

All along the road section, especially at the facades of buildings.

* How often are the measurements performed?

Every 5 years

* Can different measurement organisation be involved for a same road section?

Yes, of course

* What is the main use of acoustic monitoring?
  - ❖ **public data base**
  - ❒ Road manager's own data base
  - ❒ Road surface replacement
  - ❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

- ❒ Yes
- ❖ **No**

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO_2-emissions by using road surfaces with low rolling resistance?

- ❒ Yes
- ❒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

- ❖ **Yes (when thinking about reduction of gas and particles emissions)**
- ❖ **No (when thinking about safety; lower rolling resistance, lower contact area with pavement surface, lower traffic safety)**

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

- ❒ Yes
- ❒ No (*end of questionnaire*)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

13 – Which measurement procedure do you use?

TYROSAFE - SWEDEN

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

13- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ❒ yes
- ❒ no (*go to question 2*)

* If yes, what is the reference indicator?

* What are the legal thresholds?

* Is it checked?

By calculations

- ❒ yes (indicate the reference calculation method)
- ❒ no

By measurements

- ❒ yes
- ❒ no

* When is it checked?

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❒ Tyre noise **No**
- ❒ Road surface noise performance There is a new policy from this year
- ❒ Noise barriers construction No, not really a policy, but common practice
- ❒ Speed limits for noise reduction No, not a policy, but I think there such a case
- ❒ Other actions of traffic management (rerouting, night diversion, urban equipments…) Not a formal policy but this measure is used frequently
- ❒ Others (indicate) We have a national policy for noise immission (but not emission)

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ❒ Yes, active (mention since when)

❒ Under consideration

* Is it
  ❒ A legal scheme
  ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?
  ❒ Yes
  ❒ No (mention the exclusions)

* Does it concern?
  ❒ new tyres
  ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?
  ❒ Yes
  ❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

* What is (are) the reference speed (s)?

* What is the measurement procedure (standard, technical specification…)?

5 - Is there a national labelling procedure for noise performances of available road surfaces?
  ❒ Yes, active (mention since when)
  ❒ Not yet but under consideration We have a very detailed correction to basic noise levels for noise properties of road surfaces
  ❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)? LAeq24h, LAmax

* What is (are) the reference speed (s)? None

* What is the measurement procedure (standard, technical specification…)? Not specified

* How many worksites are necessary for obtaining the label? There are no “labels”

* How is the site-to-site variation addressed? It is not addressed

* How many labels have been delivered up to now?

* How many independent measurement organisations have been involved in this labelling?

6 – Are road noise performances specified in tendering procedures?

- ❒ Never
- ❒ Always
- ❒ Sometimes (for low noise pavements for instance)

* If noise performances are specified, how long must they be guarantied? Case to case

* Is there a procedure for the acoustic check of Conformity of Production?

- ❒ Yes at national level (mention since when)
- ❒ Yes but only at local level (mention since when)
- ❒ Not yet but under consideration We would normally measure with the CPX method
- ❒ No and not interested (*go to question 7*)

* Is this procedure applied?

- ❒ Occasionally (specify the rough percentage of cases)
- ❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)? CPX method

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…) Usually over most of the section

* What is (are) the reference speed (s)? 50, 80 and 110 km/h, if legal

* When are the measurement performed?

- ❒ Once after the work completion (specify at what age of the road surface) Varies
- ❒ Regularly (specify)

* What is the tolerance on noise levels? Not specified

* Which measures are taken if the measured noise levels are above the requirement?

- ❒ Rebuilt of the section
- ❒ Financial penalty
- ❒ None
- ❒ Others (specify) Would be determined from case to case

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?

- ❒ Never
- ❒ On some networks, depending on the network manager
- ❒ Yes, systematically
- ❒ Others

* Is there a national procedure for this acoustic monitoring?

- ❒ No (*go to question 8*)
- ❒ Not yet but under consideration

❒ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* How often are the measurements performed?

* Can different measurement organisation be involved for a same road section?

* What is the main use of acoustic monitoring?

❒ public data base
❒ Road manager's own data base
❒ Road surface replacement
❒ Others

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

❒ Yes
❒ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?

❒ Yes
❒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?

❒ Yes
❒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?

❒ Yes
❒ No (*end of questionnaire*)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

13 – Which measurement procedure do you use?

Option 1: We hire TUG to make the measurements with their trailer.

Option 2: We use a coast-down method and own instrumented vehicles at VTI

Measurement procedures are our own, based on experience

Comment: Many of the questions were impossible to answer, due to the way they were asked.

TYROSAFE – U.K.

Questionnaire on policies related to noise emission and rolling resistance of road surfaces

NOISE EMISSION

14- Are there specific national requirements regarding road traffic noise emission (other than EC Directive 2002/49/EC)?

- ❒ yes
- ☑ no

* If yes, what is the reference indicator?

* What are the legal thresholds?

* Is it checked?

By calculations

- ❒ yes (indicate the reference calculation method)
- ❒ no

By measurements

- ❒ yes
- ❒ no

* When is it checked?

* If checked by measurements, what is the measurement procedure (international standard, national standard, technical specification, others…)?

2 - Is there a specific national policy regarding actions for road traffic noise reduction regarding

- ❒ Tyre noise
- ❒ Road surface noise performance
- ❒ Noise barriers construction
- ❒ Speed limits for noise reduction
- ❒ Other actions of traffic management (rerouting, night diversion, urban equipments…)
- ☑ Others

National policy is to mitigate the effects of noise arising from traffic on the strategic network where appropriate. The UK Highways Agency is responsible for the strategic road network which comprises motorways and major trunk roads. All improvement schemes are subject to environmental appraisal and road construction projects include high standards of environmental mitigation to minimise, as far as possible the impact of noise. For new roads (trunk roads and motorways) or significant improvements to those road types, low-noise road surfaces are specified in HA contracts as a matter of course in addition to, where relevant, noise barriers. Low-noise surfaces are used for all resurfacing works on HA roads. Local authorities, who are responsible for all other roads will use low-noise road surfaces based on their own policies and requirements.

3 - Is there a specific national policy regarding tyre noise emission (other than Directive 2001/43/EC):

- ❒ Yes, active (mention since when)
- ❒ Under consideration
- ☑ No

* Is it

- ❒ A legal scheme
- ❒ A stimulation scheme

* Are all the tyres concerned (passenger cars, trucks, specifics…)?

- ❒ Yes
- ❒ No (mention the exclusions)

* Does it concern?

- ❒ new tyres
- ❒ retreated tyres

* What is the percentage of tyres concerned relative to the market?

* What is the reference indicator?

* How is it measured (standardized method or technical specification)?

* What are the noise thresholds or classes?

* Is there an estimation of the benefit in terms of traffic noise reduction?

4 – Is there a (national) definition for low noise road surfaces?

- ☑ Yes
- ❒ No (*go to question 5*)

* What is (are) the reference indicator(s) and the corresponding limit ?

The reference indicator is the ‘RSI’ (Road Surface Influence) defined as the difference between the traffic noise level calculated from the pass-by tests and the theoretical level for the reference surface in the UK traffic noise prediction model CRTN with the same traffic flow, composition and vehicle speed. This reference surface can effectively be considered as being a newly-laid 20 mm Hot Rolled Asphalt.

There is no corresponding limit value because the RSI is defined as a *reduction* rather than an absolute level, so there is instead a corresponding RSI value that defines a low-noise surface. A surface with a nominal RSI of -3.5 dB(A) or lower is defined as being a low-noise surface. This value is under review and may be revised to -5 dB(A) in the future.

* What is (are) the reference speed (s)?

High speed roads: 110 km/h for light vehicles, 90 km/h for both classes of heavy vehicles.

Medium speed roads: 80 km/h for light vehicles, 70 km/h for both classes of heavy vehicles.

* What is the measurement procedure (standard, technical specification…)?

The measurement procedure is specified in *“Guidelines document for the assessment and certification of thin surfacing systems for highways”*, SG3/08/256. Garston, UK: British Board of Agrément (2008) which forms part of the UK Highways Authorities Product Approval Scheme (HAPAS).

The procedure uses the SPB method defined in ISO 11819-1:1997, with three vehicle categories, together with some additional requirements relating to texture depth, age of the surface and temperature (air and road surface).

5 - Is there a national labelling procedure for noise performances of available road surfaces?

☑ Yes, active

The procedure is specified in *“Guidelines document for the assessment and certification of thin surfacing systems for highways”*, SG3/08/256. Garston, UK: British Board of Agrément (2008) which forms part of the UK Highways Authorities Product Approval Scheme (HAPAS). The determination of the noise level is OPTIONAL.

The procedure is currently only formally applied to thin layer surfacing systems

❒ Not yet but under consideration

❒ No interest (*go to question 6*)

* What is (are) the reference indicator(s)?

The reference indicator is the ‘RSI’ (Road Surface Influence) defined as the difference between the traffic noise level calculated from the pass-by tests and the theoretical level for the reference surface in CRTN with the same traffic flow, composition and vehicle speed. Equations have been developed for HAPAS (and are included in the Guidelines document) to allow the determination of RSI for roads classified as high-speed or medium speed, based on three vehicle categories (light vehicles, two-axle heavy vehicles, multi-axle heavy vehicles).

* What is (are) the reference speed (s)?

High speed roads: 110 km/h for light vehicles, 90 km/h for both classes of heavy vehicles.

Medium speed roads: 80 km/h for light vehicles, 70 km/h for both classes of heavy vehicles.

* What is the measurement procedure (standard, technical specification…)?

The measurement procedure is specified in *“Guidelines document for the assessment and certification of thin surfacing systems for highways”*, SG3/08/256. Garston, UK:

British Board of Agrément (2008) which forms part of the UK Highways Authorities Product Approval Scheme (HAPAS).
The procedures use the SPB method defined in ISO 11819-1:1997, with three vehicle categories, together with some additional requirements relating to texture depth, age of the surface and temperature (air and road surface).

* How many worksites are necessary for obtaining the label?

A minimum of two test locations for each road speed category, which may be on the same site provided that they are at least 100 m apart or on different carriageways.

* How is the site-to-site variation addressed?

Each site is required to meet certain texture specifications. An RSI is determined for each site and the overall label RSI is defined as being the mean of the two values.

* How many labels have been delivered up to now?

16 products have been labelled with an RSI_H value and 1 product has been labelled with an RSI_M value. In the majority of instances where the product is available using a range of aggregate sizes, the RSI label has only been determined for one aggregate size. It is assumed that the label cannot be applied to the product when constructed using other aggregate sizes. It must be noted that the noise test is optional – a total of 66 products (including all aggregate size variations of individual proprietary products) have been HAPAS certified to the minimum requirement (i.e. excluding noise)

* How many independent measurement organisations have been involved in this labelling?

It is assumed that there are at least two organisations that are HAPAS-approved in terms of undertaking the SPB measurements and similarly for the texture measurements. However none of these organisations are responsible for actually awarding the HAPAS certification (and thereby the noise label) to the surfacing product – that is the responsibility of the British Board of Agrément.

6 – Are road noise performances specified in tendering procedures?

❒ Never
❒ Always
☑ Sometimes

Low-noise surfaces are routinely specified in Highways Agency contract documents (trunk roads and motorways). Specification of road noise performance on local authority roads will be on a case-by-case basis if required.

* If noise performances are specified, how long must they be guarantied?

No guarantee of noise performance is included in contract documents. Low-noise products are procured on the basis of the HAPAS noise label, but there is no conformity of production assessment or later check that the laid surface complies with the noise label unless specifically requested.

* Is there a procedure for the acoustic check of Conformity of Production?

❒ Yes at national level (mention since when)
❒ Yes but only at local level (mention since when)

☑ Not yet but under consideration
The principles of the proposals prepared as part of the EU SILVIA project (based around SPB [ISO 11819-1:1997] and CPX [ISO 11819-2:2000] measurements) are being considered and evaluated by the UK Highways Agency within existing research projects. However there is no indication at the present time that any such procedure will be formally adopted.
❒ No and not interested (*go to question 7*)

* Is this procedure applied?
❒ Occasionally (specify the rough percentage of cases)
❒ Systematically

* What is the measurement procedure based on (reference standards, technical specification…)?

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

* What is (are) the reference speed (s)?

* When are the measurement performed?
❒ Once after the work completion (specify at what age of the road surface)
❒ Regularly (specify)

* What is the tolerance on noise levels?

* Which measures are taken if the measured noise levels are above the requirement?
❒ Rebuilt of the section
❒ Financial penalty
❒ None
❒ Others (specify)

7 – Is the acoustic monitoring of road surfaces regularly performed in your country?
❒ Never
❒ On some networks, depending on the network manager
❒ Yes, systematically
☑ Others
Monitoring is performed on a case-by-case basis when requested by the controlling road authorities, or as part of research and development projects.

* Is there a national procedure for this acoustic monitoring?
❒ No (*go to question 8*)
❒ Not yet but under consideration
☑ Yes

* What is the measurement procedure based on (reference standards, technical specification…)?

The measurement procedure is specified in *"Guidelines document for the assessment and certification of thin surfacing systems for highways"*, SG3/08/256. Garston, UK: British Board of Agrément (2008).

The procedure uses the SPB method defined in ISO 11819-1:1997, with three vehicle categories. However, CPX measurements in accordance with ISO 11819-2:2000 are increasingly being used to provide more comprehensive detail as well as allowing coverage of greater lengths of road.

* Where are the measurements performed? (Random spot(s), all along the section, at façades of buildings…)

SPB measurements are performed at locations conforming to the requirements of ISO 11819-1:1997 on the surfaces in question, the number of locations depending upon road authority requirements/specifications. CPX measurements allow whole road sections to be monitored.

* How often are the measurements performed?

Measurements are performed on a case-by case basis when requested by the controlling road authorities or as required within research and development projects. There is no formal frequency for undertaking acoustic monitoring.

* Can different measurement organisation be involved for a same road section?

Yes, but this is unlikely to occur. A single organisation will most likely to be contracted to perform all measurements along an individual road section.

* What is the main use of acoustic monitoring?

- ❒ public data base
- ❒ Road manager's own data base
- ❒ Road surface replacement
- ☑ Others

For informative purposes when requested by controlling road authorities. For research and development purposes, most commonly as part of projects which are commissioned by the UK Highways Agency. It must be noted that road surfaces are not replaced in the UK on the grounds of acoustic performance.
In the future, acoustic monitoring may be used in the development and management of noise action plans by national and local administrations.

ROLLING RESISTANCE

8 – Are there any national regulations/policies concerning a threshold for pavements' rolling resistance in your country?

- ❒ Yes
- ❒ No

9 – Is your government / road authorities aware of the potential of fuel saving and decrease of CO2-emissions by using road surfaces with low rolling resistance?

- ❒ Yes
- ❒ No

10 – Do you think there is a benefit of reducing the rolling resistance of roads pavements?
- ❒ Yes
- ❒ No

11 – Are there any measurements/projects ongoing/planned in your country/institute concerning the measurement of rolling resistance of different road surfaces?
- ❒ Yes
- ❒ No (*end of questionnaire*)

12 – What kind(s) of measurement equipment is available in your country/institute to examine pavements' rolling resistance and who is the owner?

13 – Which measurement procedure do you use?