The research leading to the results has received funding from the European Community's Seventh Framework Programme (FP7/2008-2013) under grant agreement n°217920

TYROSAFE

Final Summary Report

August 2010

Tyre and Road Surface Optimisation for Skid Resistance and Further Effects

http://tyrosafe.fehrl.org

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FINAL SUMMARY REPORT

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Table of Contents

Table of Figures

Table of Tables

List of Abbreviations

TYROSAFE - Tyre and Road Surface Optimisation for Skid resistance And Further Effects
EU - European Union
WP - Work Package
SURF - Symposium on pavement surface characteristics
TRB - Transport Research Board
TRA - Transport Research Arena
HERMES - Harmonization of European Routine and research Measuring Equipment for Skid Resistance
PIARC - The World Road Association

1 EXECUTIVE SUMMARY

TYROSAFE (Tyre and Road Surface Optimisation for Skid resistance And Further Effects) is a Coordination Action funded by the European Community's Seventh Framework Programme.

The TYROSAFE project started on the 1st of July 2008. The main objectives of the project were to raise awareness, to coordinate and prepare for European harmonisation and to optimize the assessment and management of essential tyre/road interaction parameters, in order to increase safety and support greening of European road transport.

This Coordination Action did not only focus on the road surface but also on tyres and on the interaction between the road surface and tyres. Only an optimised interaction can lead to a high level of safety for drivers on the roads in European countries while ensuring the most positive greening effect, through reduction of CO_2 output and noise emissions.

This project provided a synopsis of the current state of scientific understanding and its current application in national and European standards. It identified the needs for future research and proposes a way forward in the context of the future objectives of European road administrations in order to optimise three key properties of European roads: skid resistance, rolling resistance and tyre/road noise emission.

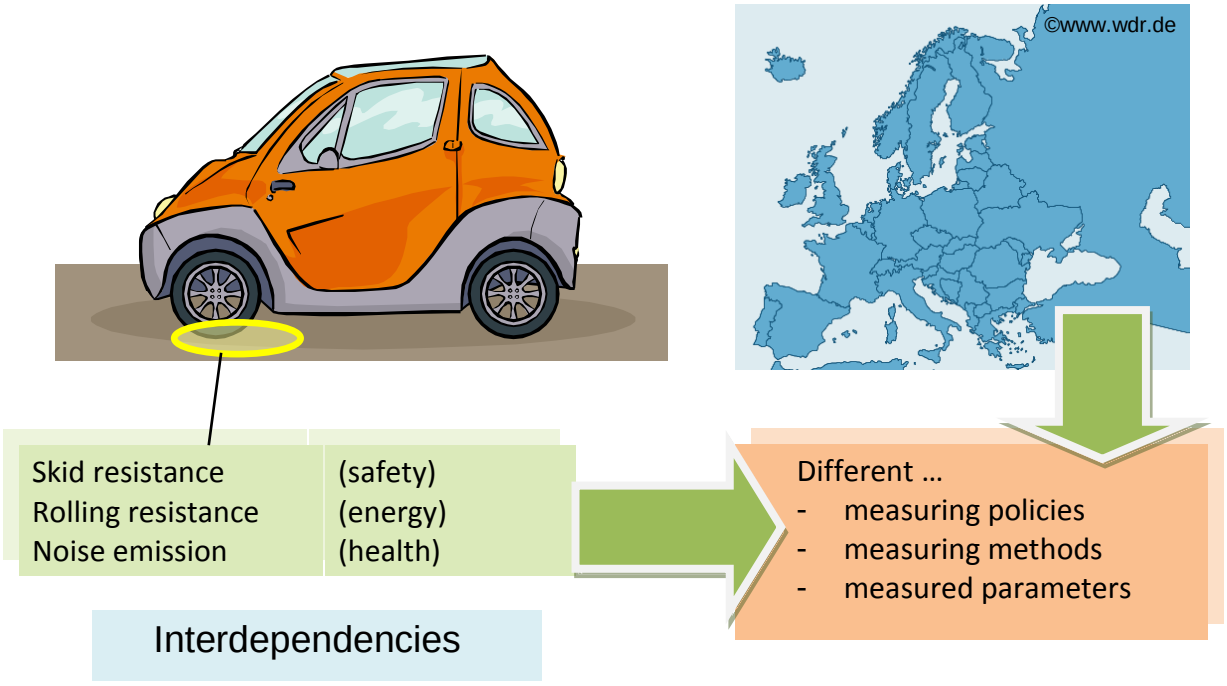
The TYROSAFE contribution in all these three areas will help the public authorities of the Member States to use existing and new research knowledge to reduce fatalities and promote environmental compatibility of road surfaces. In addition, the project created a solid scientific background for further research and for the development of harmonised policies with regard to essential road surface properties.

2 BACKGROUND & OBJECTIVES OF THE PROJECT

Road traffic in Europe plays a key role in providing mobility and flexibility to the economy and individual citizens. Road surfaces have an important, but often underestimated role in the functioning of this vital transportation network. However, research has shown that road surface properties can be used to achieve increased safety and reduced environmental impact of road traffic.

Drivers need sufficient grip between the tyres and the road to accelerate, decelerate or change the direction of a moving road vehicle. Grip is provided by the skid resistance properties of the road surface in combination with the friction characteristics of the tyre. This combination is critical for safe driving and many European countries have investigated the correlation of a low skid resistance level with accident hot spots. With a sufficiently high value of skid resistance the safety of roads can be improved and the number of accidents can be reduced.

Figure 1*: Illustration of the TYROSAFE topics*



Therefore skid resistance is a very important characteristic of the road surface influencing safety particularly because it can be improved by the design of the road surface. Yet a harmonised European scale for the measurement and assessment of skid resistance still remains to be developed. In addition to that the national policies for managing road surface properties like skid resistance differ considerably across the EU, which again makes it more difficult to provide a comparable level of safety and environmental impact all over Europe.

Environmental questions like noise pollution, air quality and consumption of energy are becoming more and more important, and any consideration of the safety benefits of improved skid resistance needs to focus on rolling resistance and noise emissions as well. Rolling resistance has to be overcome for vehicle propulsion and therefore low rolling resistance leads to reduced fuel consumption which in turn results in reduced CO2 and air pollutant output. The noise emission of road traffic is currently dominated by tyre/road noise in the speed range above 30-50 km/h. Recent research and development has provided

more silent road surfaces, however, the necessary changes in the road surface structure may engender target conflicts with other vital parameters. Currently the properties of road surfaces and tyres are not optimised to balance all of these properties evenly. Knowledge of how they interact with each other is very limited.

Moreover, the policies and standards of individual countries relating to skid resistance, rolling resistance and noise emissions vary considerably across the EU. Despite some previous activities there is a need to bring ideas together and establish what scope there is for developing a harmonised approach for the future.

The TYROSAFE project aimed at achieving the following objectives:

- Compiling, evaluating and disseminating existing expertise concerning the three key road surface parameters skid resistance, rolling resistance and noise emission
- Improving the understanding of the interactions among the road surfaces properties and - identifying knowledge gaps and needs for future research
- Planning, coordinating and fostering on-going and future research in the same field
- Preparation for European harmonisation and optimisation of the assessment and management of essential tyre/road interaction parameters
- Raising awareness of the importance of road surface properties for safety and environment
- Contributing to safer and greener road transport across Europe

3 WORK PERFORMED AND RESULTS

The project started with the kick-off meeting on 9 July 2008 in Brussels. The following section describes the main activities and results achieved in the five operative work packages (WPs).

Apart from administrative management and dissemination, there are four technical work packages dealing with the following subjects: the policies of EU countries for skid resistance/rolling resistance/noise emissions; the harmonisation of skid resistance test methods and choice of reference surfaces; road surfaces properties - skid resistance/rolling resistance/noise emissions; and the environmental effects and impact of climate change - skid resistance/rolling resistance/noise emissions.

3.1 WP 1: Policies of EU countries for skid resistance / rolling resistance / noise emissions

This work package is concerned with the policies across Europe for managing skid resistance, rolling resistance and noise emission of road surfaces. The Deliverable 6 (D06) "Report on policies and standards concerning skid resistance, rolling resistance and noise emissions" was based on the feedback to a questionnaire designed to gather information on the current policies employed to manage road surface properties. This information was complemented by the results of the first WP1 workshop on 22 October 2008 in Portorož, Slovenia, held in conjunction with the SURF 2008 (6th Symposium on pavement surface characteristics).

3.1.1 Deliverable D06: Report on policies and standards concerning skid resistance, rolling resistance and noise emissions

The D06 deliverable report analyzed the existing policies concerning skid resistance, rolling resistance and noise emission of road surfaces across Europe and found a very different situation in every field. Skid resistance is a road surface property where the majority of EU countries have introduced national policies or standards which are legally enforceable at least for motorways and primary roads. For rolling resistance national policies do not exist. Noise emission has been the subject of the European Environmental Noise Directive, but this has not resulted in a European policy on managing noise emission as a road surface characteristic.

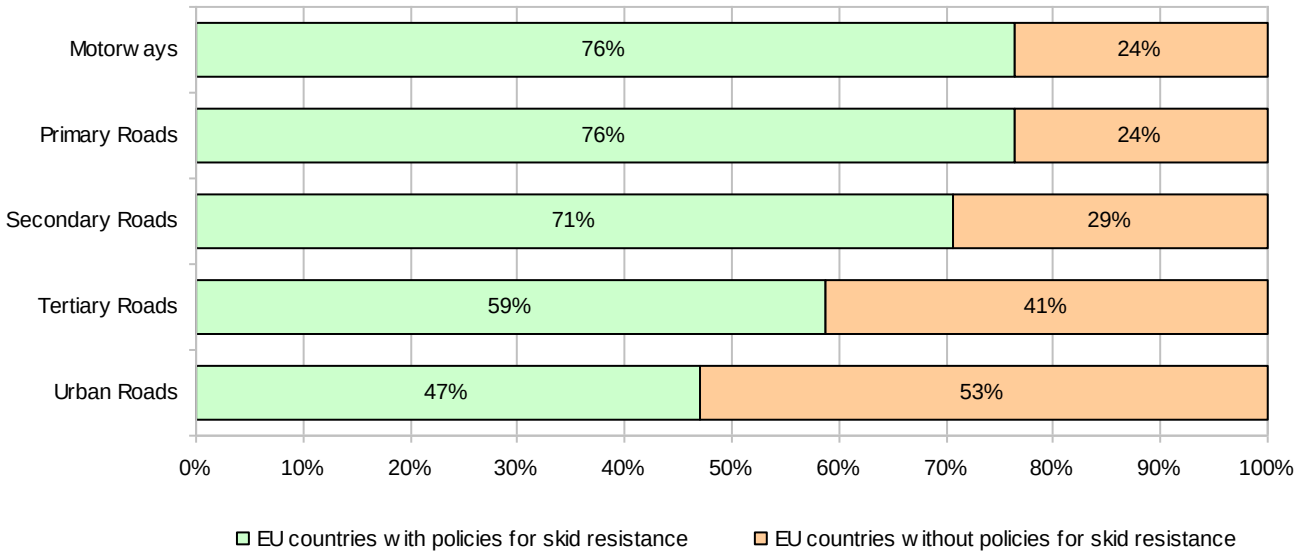
Further input was obtained from the second WP1 workshop specifically aimed at stakeholders influencing policy decisions (e.g. road administrations), which took place on 24 March 2009 in Brussels. The final output from WP1 was the second deliverable D08 "Recommendations for future harmonised EU policies on skid resistance, rolling resistance and noise emissions" that summarizes the available expertise and the exchanges with experts and stakeholders.

3.1.2 Deliverable D08: Recommendations for future harmonised EU policies on skid resistance, rolling resistance and noise emissions

The main results of D08 were recommendations for the elements of future European policies in the field of road surface characteristics. These are very similar for skid resistance, rolling resistance and noise emission. For each surface characteristic model policies set at EC level but implemented in detail in each country by their national road authorities are recommended. These include general application of policies to Level 1 and Level 2 networks (motorways and principal roads linking major towns), regular monitoring of the condition of the road network, recommendations of principles for measurement

techniques and analyses. The overall objective of equalizing skidding accident risk could be tackled by threshold levels (determined by each individual country) based on the risk of skidding on different types of sites.

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



3.2 WP 2: Harmonisation of skid-resistance test methods and choice of reference surfaces

The objective of work package 2 is to review previous harmonisation work concerning skid resistance measurements, including the topic of reference surfaces, and to create recommendations and implementation plans for the harmonisation of measuring methods.

In the first year of TYROSAFE the first three deliverable reports were completed, which lay the groundwork for the design of roadmaps for future harmonisation. The deliverables D04 “Report on state-of-the-art of test methods”, D05 “Report on analysis and findings of previous skid resistance harmonisation research projects” and D07 “Report on state-of-the-art of test surfaces for skid resistance” provide a valuable and comprehensive compilation of the results achieved so far, but also of the existing obstacles to harmonisation of skid resistance measurement in Europe.

Important input was also provided by the first WP2 workshop on 22 October 2008 in Portorož, Slovenia, held in conjunction with the SURF 2008 (6th Symposium on pavement surface characteristics) and the WP1 workshop. WP2 presented the roadmaps and strategies for future harmonisation in the second workshop on 17 September 2009, which form the basis of the final deliverable D09 “Road map and implementation plan to future harmonised test methods and reference surfaces”.

3.2.1 Deliverable D04: Report on state-of-the-art of test methods

The D04 report on state-of-the-art test methods for skid resistance showed that even the main operating principles of skid resistance test devices are not uniform across Europe. They employ the measurement of longitudinal friction, transverse friction and sliders. Twenty-three devices were

identified from CEN TC227 WG5, which is the CEN body concerned with road surface characteristics and their measurement, and project partner sources. For each device, the measurement principle and test method were described. This first overview showed a wide variety of measurement configurations and test conditions, ranging from static spot-check devices through large-scale routine investigation tools to research equipment for specialized purposes. As a result making comparisons between tests results from different countries is currently very difficult, even when employing simple mathematical models to derive conversion formulas.

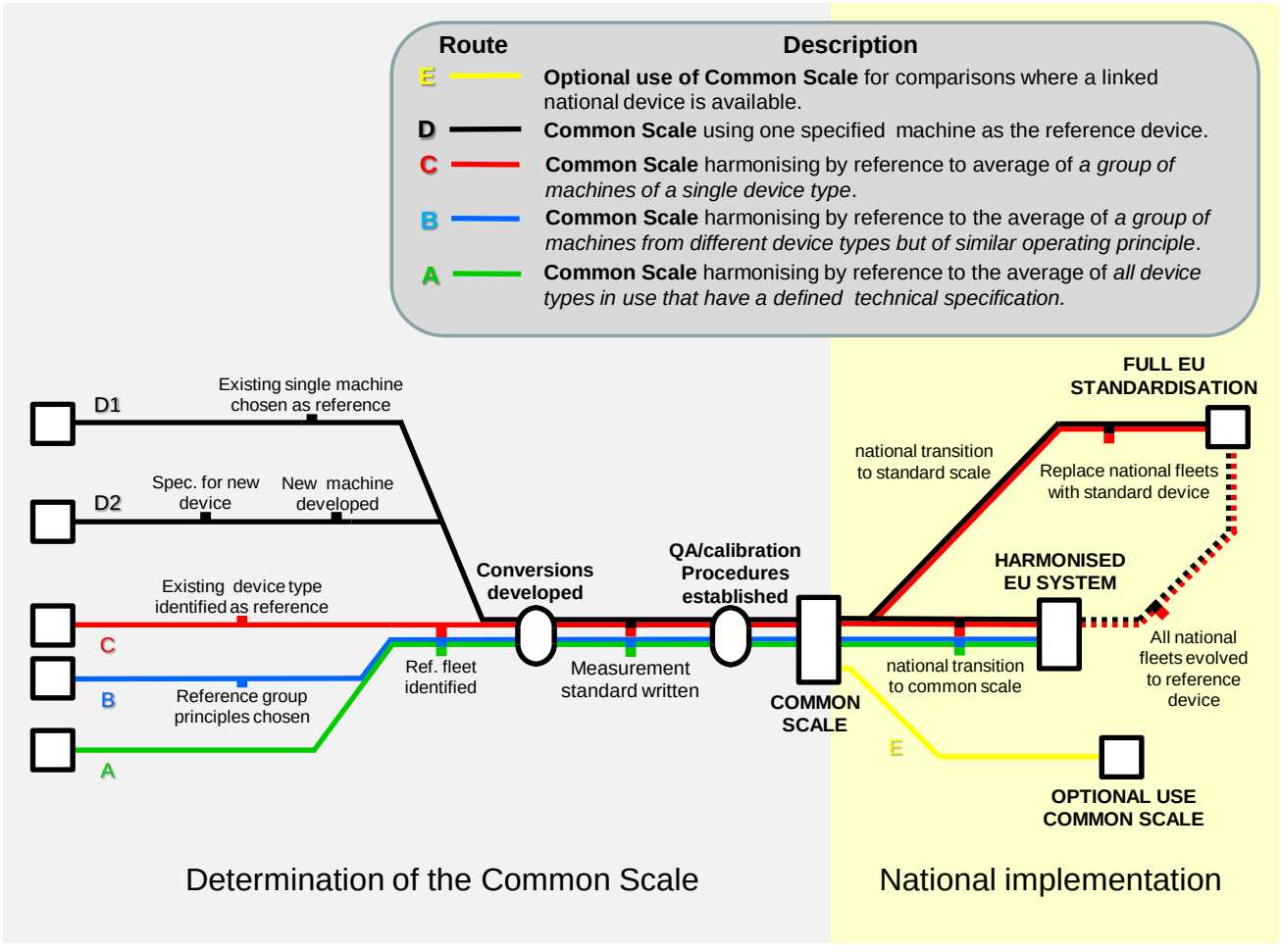
3.2.2 Deliverable D05: Report on analysis and findings of previous skid resistance harmonisation research projects

The D05 deliverable investigated the progress made with former projects and attempts at harmonisation of skid resistance measurements, like the HERMES project or the PIARC experiment. Although some progress has been made and some promising concepts have been proposed, there is not yet a scale or system that can harmonize the range of devices currently used in Europe with sufficient precision to be of practical application with widespread acceptance. This will need to be addressed in further research benefiting from the lessons learned in earlier attempts.

3.2.3 Deliverable D09: Road map and implementation plan to future harmonised test methods and reference surfaces

The D09 deliverable presents the different available roads to harmonisation in the form of a roadmap, listing the advantages and disadvantages, obstacles and approximate costs for each approach. Recommendations are given both for a short-to-mid-term term harmonisation strategy as well as for required research both in the short and long term. The results of the second WP2 workshop were integrated into the main findings of D09, which are presented below.

Figure 3: *The TYROSAFE roadmap to skid resistance measurement harmonisation ("Metro Map")*



The final recommendations of the TYROSAFE team include a Harmonised EU system for skid resistance measurements using current devices reporting on a Common Scale (with defined accuracy classes) based on the average of a defined set of existing devices in the medium term (5-7 years).

It v l to determine appropriate conversions and their accuracies to link the various devices to the chosen Common Scale. This will require substantial technical and research work. In parallel the TYROSAFE team recommends to make a broad review of the ways in which skid resistance measurements are currently used to assess accident risks and to develop a specification for a new type of measurement device designed to giving a fundamentally better estimate of the influence of skid resistance on accident risk. This should be the basis for a new skid resistance measurement prototype device, which could in the long term replace other devices. This also requires a parallel development of a set of suitable and stable reference surfaces to calibrate the Common Scale.

3.3 WP 3: Road surfaces properties– skid resistance / rolling resistance / noise emissions

This work package was concerned with examining the different basic parameters of road surfaces and tyres which in turn influence the key parameters skid resistance, rolling resistance, noise emission. Special attention will be given to their interdependencies, optimization potentials and knowledge gaps.

WP3 work in the first year of TYROSAFE focused on preparations for the first deliverable D10 “Report on different parameters influencing skid resistance, rolling resistance and noise emissions” which was delivered after the end of the first reporting period in August 2009. A WP3 expert workshop was organized to provide input for D10 which took place on 13 May 2009 in Brussels. The group of experts assembled at this workshop represented most of the European research community in the field of skid resistance, rolling resistance and noise emission of road surfaces. A final WP3 workshop was held on 10 February 2010 at the Tire Technology Expo in Cologne.

3.3.1 Deliverable D10: Different parameters influencing skid resistance, rolling resistance and noise emissions

The deliverable D10 reported on the different parameters influencing skid resistance, rolling resistance and noise emissions. All three properties are influenced by road surface, tyre and environmental parameters. The greatest amount of research has been directed at understanding tyre/road friction, especially in wet conditions, and its two contributing components – road surface skid resistance and tyre wet grip. Studies of noise generation have been continuing for some 20 years or so and the basic mechanisms are reasonably well understood, as are some of the properties of road surfaces and tyres that can contribute to reduced tyre/road noise. However, the physical processes involved and the interactions between them are complex and this still presents a challenge for research. Rolling resistance research is, by comparison, still in its infancy: Measurement techniques are limited and evidence supporting an intuitive understanding of how the road contributes to rolling resistance is just beginning to be obtained.

Throughout the review it has become clear that the properties of friction, rolling resistance and noise are predominantly and essentially influenced by a relatively small number of general properties of the road surface and the tyre. In short, these are:

- Road surface texture (at different scales and with different forms).
- Tyre treads (particularly compound, tread depth).

3.3.2 Deliverable D15: Report on knowledge gaps and proposals for further research concerning optimisation for road surfaces and tyres for skid resistance, rolling resistance and noise emissions

Although the number of core parameters is relatively small, behind this rather simple summary, numerous other influencing factors exist. The final WP3 Deliverable D15 will detail the remaining knowledge gaps and the research needed to promote the understanding of tyre/road interaction.

3.4 WP 4: Environmental effects and impact of climatic change – skid resistance / rolling resistance / noise emissions

Work package 4 supplements the other work packages by looking at environmental effects and the impact on climatic change in relation to road surfaces and tyres for skid resistance/rolling resistance/noise emission.

3.4.1 Deliverable D12: Report on future research areas for environmental effects - A summary of the environmental impacts of tyre/road surface interaction and the identification of future research areas

D12 "Report on future research areas for environmental effects - A summary of the environmental impacts of tyre/road surface interaction and the identification of future research areas", also includes input from a workshop held on 2 December 2009 in Cologne.

Among the potential areas for further research identified in D12 were the following:

- The extent of use of polish-resistant aggregates across Europe and the environmental effects associated with an increase in their use, for example transport emissions
- How to make the best use of polish-resistant aggregates and alternative methods of increasing skid resistance
- Particulates from tyre and road wear and their impact on skid resistance through build up during drought conditions, viscous aquaplaning and summer polishing
- Tyre noise and rolling resistance in the wet
- Electric vehicles and skid resistance requirements
- Weather thresholds for seasonal skid resistance variation
- The implications for skid resistance of longer heavier vehicles
- The implications of less winter maintenance (as a result of milder winters) on skid resistance
- Climate change effects on surface durability

3.4.2 Deliverable D16: possible impact of climatic change on road surfaces and tyres

The final Deliverable D16 will report on the possible impact of climatic change on road surfaces and tyres with regard to skid resistance, rolling resistance and noise emission.

3.5 Work package 5: Dissemination and raising awareness

WP5 tasks were the dissemination of project results, organising internal and external communication, and raising awareness of the project topics. The basic tools and concepts were created at the start of the project with D01 "Project website" and D02 "Report on Dissemination Strategy".

3.5.1 Deliverable D01: Project website

The project website features basic project information, public documents like deliverables and presentations, a forum and an event calendar and a regularly updated news section.

The TYROSAFE website homepage*:*
http://tyrosafe.fehrl.org

The website consists of a public and a private section. The public section comprises all material accessible to the general public, whereas the private section has some additional pages and tools intended for internal organisation of the project. The content of the private section is only viewable after performing a login via username and password entry. Access to the private section of the TYROSAFE project website is restricted to the TYROSAFE project workers, who are required to register in order to be able to access the internal information. The public section is managed centrally by the project coordinator and WP5.

Other WP5 activities were the establishment and the first meetings of the stakeholder reference group, the regular publication of a newsletter and the design of a project logo and leaflet.

3.5.2 Deliverable D02: Report on dissemination strategy

The guidelines of this dissemination are based on the following principles:

- Dissemination is basically “knowledge sharing” and bi-directional,
- Liaisons with industrial, research and standardisation communities,
- Developing a website which contains both a public part and a private part to be used only by the project partners,
- Regular workshops and seminars, organised as parts of appropriate international or regional events in the area of road infrastructure,
- Involving an expert group having an advisory and consulting role within the project,
- Establishing a close collaboration with other projects e.g. through FEHRL’s Strategic European Road Research Programme (SERRP) cluster,
- Producing regular newsletters,
- Publishing project results in relevant scientific journals.

Additionally TYROSAFE was present at many international events and conferences like SURF 2008 (Slovenia), Tire Technology Expo 2008 and 2009 (Germany), the National Seminar on Evaluation of Pavement Surface Characteristics 2008 (Portugal), the Institute of Asphalt Technology National Conference 2009 (UK), the Aula INECO 2009 (Barcelona), European City of Science 2008 (France), Research Connection 2009 (Prague), CEN/TC 227/WG5 (France), TRB (US) and ERTRAC (US), the CERTAIN National Seminar 2009 (Slovenia) and the Tire Technology Expo 2010 in Cologne.

The final event of the TYROSAFE project is organised on the last day of the TRA 2010 conference in Brussels, 10 June 2010.

3.5.3 Deliverable D13: TYROSAFE YouTube Video Competition

TYROSAFE sponsored an online video competition that ran from 19 June 2009 to 31 March 2010. The aim of the competition was for participants to create a short video that conveys the importance and raises awareness about the interactions among tyres, roads and safety, to the general public. A panel of judges from the road research industry decided on a winner from various entries. The winning video will be awarded and shown at TRA 2010 during the Final Seminar.

The video will be used to raise awareness and promote the TYROSAFE project at different exhibitions, seminars and project events.

Additional information: http://www.youtube.com/tyrosafe

4 DISSEMINATION ACTIVITIES

4.1 Overview

The key dissemination and implementation activities of the project included:

- **Workshops.** Organisation of workshops to get feedback from stakeholders and to present the results of the project.
- **Contact with Stakeholders Reference Group.** Dissemination of the results of the project in the different industries represented by members of the group
- **Preparation of papers**. Preparation of papers for international conferences, articles for national journals, newsletters for end users and networking.
- **Clustering with other projects.** Link with different research projects as part of the FEHRL Strategic European Road Research Programme (SERRP).
- **Internet site**. Creation and maintenance of the public website.
- **Dissemination materials**. Development of materials for use in national follow-up presentations of project progress and results.

During the life of the project, TYROSAFE was presented at a number of events and through a range of distribution channels; the following table summarizes these various activities.

Table 4-1 List of the dissemination activities carried out during the TYROSAFE Project

Date	Name, type of Event and Place	Audience type	Audience size	Partner involved	Type of activity
19-21.2.2008	Tyre Technology Expo 2008, Cologne, Germany	Stakeholder, researcher	1500	Arsenal/AIT	Presentation
02.04.2008	Open Space for European Research, Vienna Austria	Stakeholder, researcher		Arsenal/AIT	Poster presentation
31.08.2008	TYROSAFE website	General public		FEHRL	Website
20-22.10.2008	SURF 2008 conference	Stakeholder, researcher	750	Arsenal/AIT	Presentation
22.10.2008	WP 1 workshop at SURF 2008	Stakeholder, researcher	40	WP 1 + guests	First WP 1 workshop
22.10.2008	WP 2 workshop at SURF 2008	Stakeholder, researcher	40	WP 2 + guests	First WP 2 workshop
20.11.2008	Seminar: Evaluation of pavement surface characteristics, Guimaraes, (Portugal)	Stakeholder, Researcher	100	TRL	TYROSAFE presentation
17-19.02.2009	Tire Technology Expo 2009, Hamburg, Germany	Stakeholder, researcher	1500	Selected TYROSAFE speakers	TYROSAFE session
02.2010	Tire Technology Expo 2010, Cologne, Germany	Stakeholder, researcher	1500	Selected TYROSAFE speakers	TYROSAFE session
24.03.2009	WP 1 workshop in Brussels	Stakeholder, researcher	20	WP 1 + guests	Second WP 1 workshop
13.05.2009	WP 3 workshop in Brussels	Stakeholder, researcher	30	WP 3 + guests	First WP 3 workshop
14.05.2009	Institute of Asphalt	Road Construction	150	TRL	TYROSAFE

	Technology National Conference 2009 in Durham (UK)	Industry, Stakeholders			presentation as part of longer talk
20.04.2009	Aula INECO 2009 at TU Barcelona	Researcher	30	Arsenal/AIT	TYROSAFE presentation
14-16.11.2008	European City of Science (ECS 2008), Paris, France	General public	42600	FEHRL	TYROSAFE stand
16.02.2009	Article on TYROSAFE participation in ECS2008	General public		FEHRL	Article about TYROSAFE
7-8 May 2009	Research Connection 2009 Prague (Czech Republic)	Scientists, industrialists, researchers, general public	1310	FEHRL	TYROSAFE stand
4-5 June 2009	CEN TC 227 WG5 Lyon	Industry and researchers		RWS	Presentation of TYROSAFE project
11-15 January 2009	TRB Washington (USA)	Stakeholder, researcher	10000	FEHRL	TYROSAFE stand
26 January 2009	ERTRAC	Commission, industry, cities, automotive	120	FEHRL	TYROSAFE stand
6-7 May 2009	CERTAIN National Seminar in Bled (Slovenia)	Stakeholder, researcher	150	ZAG	Presentation
12.2008	1st TYROSAFE newsletter	TYROSAFE mailing list		Arsenal/AIT	Newsletter
01.2009	2nd TYROSAFE newsletter	TYROSAFE mailing list		Arsenal/AIT	Newsletter
06.2009	3rd TYROSAFE newsletter	TYROSAFE mailing list		Arsenal/AIT	Newsletter
02.2010	4th TYROSAFE newsletter	TYROSAFE mailing list		Arsenal/AIT	Newsletter
05.2009	Organisation of the TYROSAFE video competition	Young researcher		FEHRL	Video
09.2008	Publication on World Highways, p.17 www.worldhighways.com	Stakeholder, researcher, industry		FEHRL	Paper
09.2009	WP 2 workshop in London	Stakeholder, researcher	30	WP 2 + guests	4th workshop
12.2009	WP 4 workshop in Cologne	Stakeholder, researcher	30	WP 4 + guests	5th workshop
10-12-01-2010	TRB Washington (USA)	Stakeholder, researcher	10000	FEHRL	TYROSAFE stand
02.2010	WP 3 workshop in Cologne	Stakeholder, researcher	30	WP 3 + guests	6th workshop
04.2010	TRL news	Stakeholder, researchers	8000	WP4	Short article
05.2010	16th IRF (International Road Federation) World Meeting in Lisbon	Road Construction Industry, Stakeholders	1200	Arsenal/AIT	Conference paper
05.2010	Article in Highways Magazine	UK Road Industry, Stakeholders		TRL	Magazine article

05.2010	Organisation of the TYROSAFE professional video	General public		FEHRL	Video
06.2010	FINAL EVENT at TRA2010 in Brussels	Stakeholder, researcher, industry	30-40	External experts	Final event

4.2 Follow-up activities

All of the TYROSAFE deliverables, the public material produced during the TYROSAFE project, the presentations at the TYROSAFE workshops, and at the Final Event, will be available on the public part of the website http://tyrosafe.fehrl.org. In addition to the website, the Knowledge Base, videos, reports, papers and the registration of the workshops will continue to be available after the end of the project.

Concerning follow up activities, all of the TYROSAFE partners will continue their activities in this area of research. Partners are also involved in other National and European projects and in standardization activities and they will spread the TYROSAFE knowledge in follow-up research.

Some potential dissemination activities after the project have already been suggested in section 6.1, in the discussion of the boundary conditions for follow-up research.

The need to strengthen the link between tyre and pavement industry has also been emphasized and in this context a special session is being arranged at the Tire Technology Conference and EXPO 2011 to be chaired by Peter Roe (TRL) of the TYROSAFE group. The intention is to use this session to increase awareness and promote discussion of tyre/road interaction research issues within the tyre industry.

5 EXPLOITATION OF RESULTS

The long term objectives of the TYROSAFE project are the improvement of road safety and the reduction of the environmental impact. Reaching those objectives requires a strategic approach. Three key strategic components are: the development of policies and standards at European level to improve the quality of road surfaces; provision of measurement tools to enable consistent assessment of road surfaces and tyres; material specifications to set the basic requirements for road surfaces and tyres.

A significant strategic proposal from the project is the importance of developing consistent policies for the management of skid resistance, rolling resistance and noise at the EU level, with local application in individual Member States. These should be supported by consistent measurement techniques for monitoring the road network and, for skid resistance in particular, the current situation of over 20 different devices providing results that cannot be compared directly needs to be replaced by a harmonised approach that allows the results to be compared on a Common Scale. To this end, TYROSAFE has prepared a Road Map offering different routes to achieving this outcome.

Underpinning the three strategic components will be a number of research activities and TYROSAFE has set out proposals for these, directed towards supporting policies, enabling optimisation of road surfaces and tyres while reducing environmental impact and anticipating the effects of climate change.

The proposals range from major tasks of strategic importance to areas that will increase scientific knowledge but are of longer-term interest and application. It is important to recognize that within these research suggestions there are inter-dependent or complementary ideas that could potentially take some 10 years to deliver in various stages.

The most significant proposal is the need to increase understanding of the combined influence of texture of roads and tyres in the tyre/road interface, including the development of alternative measurement techniques and parameters to those currently used which limit what can be studied at present. Understanding texture is essential to carry forward the ideas for harmonisation and optimisation of all three properties (skid resistance rolling resistance and noise) addressed by TYROSAFE.

Carrying out the research and implementing its findings will be heavily dependent on appropriate support and sponsorship at a European level, especially from road administrations. Greater co-operation between researchers in the various components of the road and tyre industries will be important; boundary conditions for the implementation of the further research have been discussed.

6 IMPLICATIONS FOR SOCIETY

The previous chapter reviewed the main findings from TYROSAFE: this chapter summarises the likely societal implications that can be expected if and when the project's recommendations are adopted.

6.1 Improved road safety

Under the heading of improved road safety, the most important and most obvious direct benefit of implementing the findings of TYROSAFE is the reduction in the numbers and severity of road traffic accidents, leading to a reduction in deaths and injuries as well as other consequential costs. Some other societal benefits are as follows:

- Harmonisation of skid resistance policies and measurements will help countries with no guidelines or that have no background in measuring skid resistance with the start they need in monitoring skid resistance on their road network. Harmonised policies could also lead to an increase in skid resistance requirements in some countries. In such countries less maintenance could be required as skid resistance should remain higher for longer. This will also lead to a reduction in the environmental impacts associated with maintenance.
- Harmonisation of skid resistance could result in changes to policy in relation to the specification or procurement of surfacing materials. For example, highway authorities might introduce certificates of production and quality schemes, which are often based on a material or system's performance rather than its constituents.
- For questions of road safety performance, the project's findings offer the possibility of bench-marking by defining a minimum required level of road safety regarding friction supply and demand.
- With harmonised measurements, EU road authorities, surfacing contractors and material suppliers would have a consistent way of specifying and verifying the acceptability of new surfacings. Road authorities who already monitor skid resistance but wish to compare standards with others based on different measurement methods would have a convenient tool for doing so.
- TYROSAFE provides the possibility of knowledge transfer between road owners, tyre manufacturers and the road construction industry on how to achieve greater road safety by means of optimized pavement design and optimized tyres.
- One of the top priorities of the EU is in the breaking of barriers and opening of internal markets, with potential for increased cross-border travel of people and goods. Harmonisation of policy relating to the key properties would make the situation on the road more predictable for the user and ease comparison of safety levels between countries.

6.2 Greener transport

Vehicle fuel consumption is strongly linked to tyre rolling resistance which is influenced by the road surface characteristics. TYROSAFE has studied the influence of tyre-road interaction on rolling resistance and the most obvious benefit of its findings is a reduction of the rolling resistance as a result of choosing the optimal tyre/road combinations.

This has a positive effect in reducing fuel consumption and hence a decrease in CO_2 contribution. Further, reduced fuel consumption would reduce other greenhouse gas emissions. In addition to reducing fuel consumption, GHG and other exhaust emissions, low rolling resistance roads could also reduce tyre wear and the generation of particulates. As well as reduced local pollution, fewer

particulates mean less clogging of porous surfacing, so such surfacings require less cleaning and retains their noise-reducing properties for longer.

Other important societal benefits are as follows:

- Optimized pavements and tyres need less maintenance, which decreases the amount of raw materials consumed and energy used in production and also leads to a reduction of disposal problems.
- As mentioned earlier, implementation of TYROSAFE findings will lead to fewer accidents and, as a consequence, less congestion, which itself means a reduction in fuel consumption and associated pollutants.
- Harmonisation of rolling resistance measurements will offer the possibility of bench-marking by defining the maximum permitted level of rolling resistance.

6.3 Improved health conditions

There is no doubt that noise causes or contributes to a number of severe health consequences (see Chapter 2). Noise exposure has also been known to induce tinnitus, vasoconstriction and other cardiovascular impacts. Beyond these effects, elevated noise levels can create stress, increase workplace accident rates, and stimulate aggression and other anti-social behaviors. Traffic noise is one of the most significant causes for every day noise. Reduced traffic noise by optimising tyre/road interaction potentially has a strong beneficial impact on peoples' health.

The TYROSAFE study provides the possibility to use a better understanding of the noise emission process in order to create low noise tyre-pavement combinations and to reduce the traffic noise at source. Additionally the project's findings provide the necessary information to define a maximum allowed level of traffic noise which will result in the transfer of a future bench-mark into practice. This will also contribute to better cooperation between the tyre and road industries.

7 CONCLUSIONS

The results of the project include a thorough evaluation of the role of the key road surface parameters skid resistance, rolling resistance and noise emission of road surfaces in the context of the European road transport system including their interdependencies and the interaction with the climate.

TYROSAFE has managed to provide an overview of the state of the art and of the remaining knowledge gaps to be closed, as well as recommendations for managing essential road surface properties. A possible way to the future harmonisation of policies and assessment methods has been shown. The implementation of the proposed policies and systems will finally depend on decisions made by stakeholders in road transport like road administrations and transport ministries, which go beyond the scope of this project.

Common and compatible assessment management of road surface parameters in Europe will in turn provide more safety and reduced environmental impact. Wider implications are the reduction of accidents and the reduction of CO_2, air pollutant and noise emission from road traffic. This will benefit both the European economy and the general public relying on road transport as an efficient, safe and ecologically sustainable transportation system.

Additional information on all of public deliverables can be found here:

http://tyrosafe.fehrl.org/index.php?m=49&id_directory=977

8 REFERENCES

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See additional references in the individual reports at: http://tyrosafe.fehrl.org

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