Project ROSANNE: Rolling resistance, Skid resistance, and Noise Emission measurement standards for road surfaces

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ABSTRACT

ROSANNE is a collaborative project in the Seventh EU Framework Programme which aims at developing/harmonising measurement methods for skid resistance, noise emission and rolling resistance of road pavements as a preparation for standardization. To achieve this, the project will follow the recommendations of key predecessor projects as well as consider ongoing work in CEN and ISO. The project will develop and improve standards in the field of working group CEN/TC 227/WG 5. For the pavement influence on road traffic noise emission the main objective is to consider the existing measurement methods of SPB (ISO 11819-1) (1) and CPX (ISO/DIS 11819-2) (2) to provide a stable and reliable harmonised method for pavement noise emission properties. The project will validate these methods and a combination of them, incorporate correction mechanisms for temperature influence and investigate its potential use for noise immission calculation methods like the one proposed by the CNOSSOS-EU project (3). It will also explore the potential for recent developments in the measurement of surface texture to deliver parameters that better reflect the physical process of tyre/road interaction and that may improve our understanding of how the texture influences noise emission. The present paper summarizes the project status after the first nine project months.

Keywords: tyre/road noise, pavement, road surface, noise measurement methods
I-INCE Classification of Subjects Number(s): 52.3, 76.1.1, 81.2

1. INTRODUCTION

The major challenge of the European road networks is to provide efficient transportation while maintaining high standards with regard to road safety, public health and environmental impact. Road administrations have to achieve cost-effective management of their networks while facing requirements to contribute to a reduction in accident rates, noise pollution of residential areas and greenhouse gas emissions of road vehicles. Road surface parameters play a key role in the options available on a national and international level to achieve these desirable results.

Previous research, especially in the TYROSAFE project (4), has shown that controlling skid resistance, noise emission and rolling resistance of pavements enables road administrations to make a beneficial contribution to making road transport safer and greener. The same research also shows that assessment methods and policies for these three road surface parameters vary greatly across Europe; if at all available. In the case of skid resistance, for instance, not even the physical property that is measured is exactly the same. In the case of rolling resistance there is not even any generally recognized measurement method available. In the case of noise emission, the two main measurement methods available provide different indicators whose correlation has not yet been established.

This leads to the situation that while their importance is recognized, the exchange of expertise and good practice among EU countries faces considerable barriers. For this reason any steps forward in developing and harmonising the assessment of skid resistance, noise emission and rolling resistance

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will contribute to the reduction of accidents, noise pollution and greenhouse gas emission. Additionally, it will reduce trade barriers, e.g. for the supply of road surfacing materials and the provision of road survey services, and foster innovation in the road construction sector. Standardization of these methods could prove even more beneficial, provided the necessary pre-normative research is carried out.

2. PROJECT OVERVIEW

2.1 Project structure

ROSANNE started in November 2013 and will run for a time period of three years. The main objective of ROSANNE is to develop and/or harmonize measurement methods for skid resistance, noise emission and rolling resistance of road pavements as a preparation for standardization. An overview of the work package structure of ROSANNE is given in Figure 1. As road surface texture is the main influence parameter of the pavement on these three surface properties under consideration, special focus will be laid on the interrelations of the texture in work package 4.

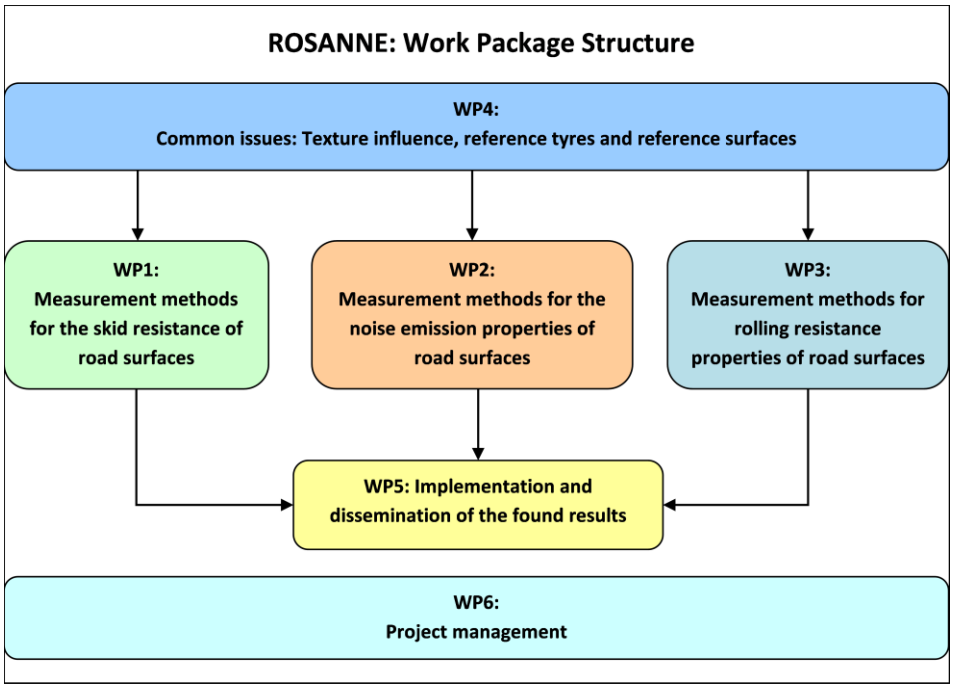

Figure 1 – Work package structure of ROSANNE

This paper will focus on the noise emission properties of road surfaces; i.e., work package 2. Its main aim is to consider the existing measurement methods (SPB and CPX) for providing a harmonised characterization method for pavement noise emission properties. An evaluation of its viability for acceptance testing, monitoring and compatibility with environmental noise calculation methods like CNOSSOS-EU will also be carried out. Remaining problems with the measurement methods, such as reference tyres and the influence of temperature will also be addressed.

2.2 Noise emission properties of road surfaces

In recent years low-noise road surfaces have become more and more accepted as an effective means of road traffic noise abatement which has some key advantages over other options like noise barriers. Low-noise pavements reduce tyre/road noise at the source and the noise reduction does not depend on the relative position of noise source and receiver. Moreover, they do not provide a visual barrier. Significant and beneficial noise reduction up to 10 dB(A) can be achieved in addition to other noise source limitations on vehicles and tyres. The European Environmental Noise Directive 2002/49/EC (END) (5) obliges the Member States to create noise maps around the major roads and inside the main agglomerations and to accompany them with action plans which could employ low-noise pavements as a key element. Therefore it is crucial to correctly characterize the acoustic performance of pavements

for approval testing, life-cycle monitoring and in connection with environmental noise calculation methods.

Road authorities need such a characterization method in order to introduce specifications in the tenders for road surface renewals. Furthermore, road manufacturers also need a characterization method to compare their products, develop quieter products and thus increase their competitiveness. Functional requirements such as planned here will also foster innovations. Because the noise performance of a given type of pavement can be difficult to reproduce from one construction site to another, it is also very important for road authorities to have a measuring method for checking the actual noise reduction once the new pavement is laid down. Also because noise properties of road surfaces are not stable over time, there is a need for road owners to monitor the acoustic performances of their network. Finally, in order to draw the strategic noise maps as requested by END and to design appropriate action plans, the responsible authorities need accurate and comparable input data related to the noise quality of the road surfaces. The acoustic properties of low-noise road surfaces have been or are being investigated in European projects like SILVIA (6), SILENCE (7) or PERSUADE (8), among others.

The key standards for determining the pavement influence on road traffic noise emission are ISO 11819-1 (Statistical Pass-By or SPB method) and ISO/DIS 11819-2 (Close ProXimity or CPX method). While the SPB method relies on recording the sound pressure levels and speeds of passing-by vehicles at the roadside, CPX uses trailers or self-powered vehicles fitted with microphones close to the tyre/road contact of selected reference tyres. These methods offer complementary advantages and are continually improved by the responsible ISO working group, which is ISO/TC 43/SC 1/WG 33. The few existing national noise characterization procedures typically use different variants of one or both methods.

Characterization methods for noise properties of pavements used for approval testing, monitoring or the determination of input values for noise calculation procedures are available in some European countries at the national level. However, they use a variety of methodologies, based on several measurement methods and different references. Input road data for environmental noise calculations are currently often linked to the various national noise calculation schemes, and exhibit other national specifics, which makes results in general incomparable. However, in the common noise calculation method envisaged in the END and defined to date within the CNOSSOS-EU report, road surface noise corrections are introduced as input parameters in the road traffic noise emission model. A common European methodology to determine these road surface noise corrections is under discussion. It is of importance to check the applicability of this methodology to the more general purpose of road surface classification and its consistency with other envisaged methods.

Within the European project SILVIA, finished in 2005, a first proposal for such a common European noise characterisation methodology was presented. The data it delivered were as far as possible suitable for adaptation for input into national noise calculation schemes and the HARMONOISE/IMAGINE noise prediction model (9, 10) which was, at the time, expected to be the future European harmonized noise prediction model. The SILVIA project concluded before any validation of the characterization methodology was performed and there has, at best, only been a very limited adoption of the principles of the methodology.

3. DEVELOPMENT OF A NOISE CHARACTERIZATION METHOD

To achieve the objective of producing a useful method for characterizing the noise emission properties of road surfaces, it is necessary to settle some remaining technical issues with the basic SPB and CPX standards; primarily the temperature influence on tyre/road noise. For the CPX method, additionally, reference tyres must be specified. It may also be necessary to define additional parameters and topics not treated within the current measurement standards, such as details related to the lateral road position of measurement, required lengths for measurements (sample size), frequency or period of measurement, etc. Finally, a generalized method for describing the noise emission properties of road surfaces shall be developed on the basis of these two measurement methods, or based on only one of them (in the latter case, probably the CPX method). The compatibility with the noise calculation models shall be investigated and validated. An outline of the work structure is depicted in Figure 2.

3.1 Analysis and comparison of existing noise measurement methods

For the characterization of the noise emission properties of road surfaces, the standards

ISO 11819-1 (SPB method) and ISO 11819-2 (CPX method) are the most common measurement methods in Europe. In USA, they use a variant of the CPX method, called the OBSI method (on-board sound intensity). While both the SPB and the CPX methods aim at providing a method for measuring the influence of road surfaces on traffic noise, their approach differs. While the SPB method measures vehicle noise, it relies on the representativity of the current traffic collective at the measurement site, which is a spot. On the other hand the CPX method provides the opportunity to measure tyre/road noise over an arbitrary length of the pavement, and also how its properties vary along the road. The SPB method has the disadvantage of providing only a spot measurement, as well as it can be used only where the acoustical environment near the spot is undisturbed and non-reflecting, and it is often difficult to find the traffic volumes making the measurement practical. The CPX method measures only a part of the noise from the road traffic, namely tyre/road noise, and for a limited set of test tyres (two); however, tyre/road noise is mostly the dominating type of noise when noise properties of pavements are of interest. The CPX method relies on the control of tyre parameters as tyre type, age, rubber hardness, etc., whose impact on the generated noise are being investigated. As already mentioned, these methods offer complementary advantages and a first task has been started in the course of ROSANNE to investigate on the correlation between both method and to possibly establish a relationship.

One of the most substantial influences on both methods is the temperature, which can be measured as air, surface and/or tyre temperature. Which of these parameters that are the most suitable to provide the basis for a correction factor will be investigated in the course of ROSANNE in close cooperation with ISO/TC 43/SC 1/WG 27 and CEN/TC 227/WG5.

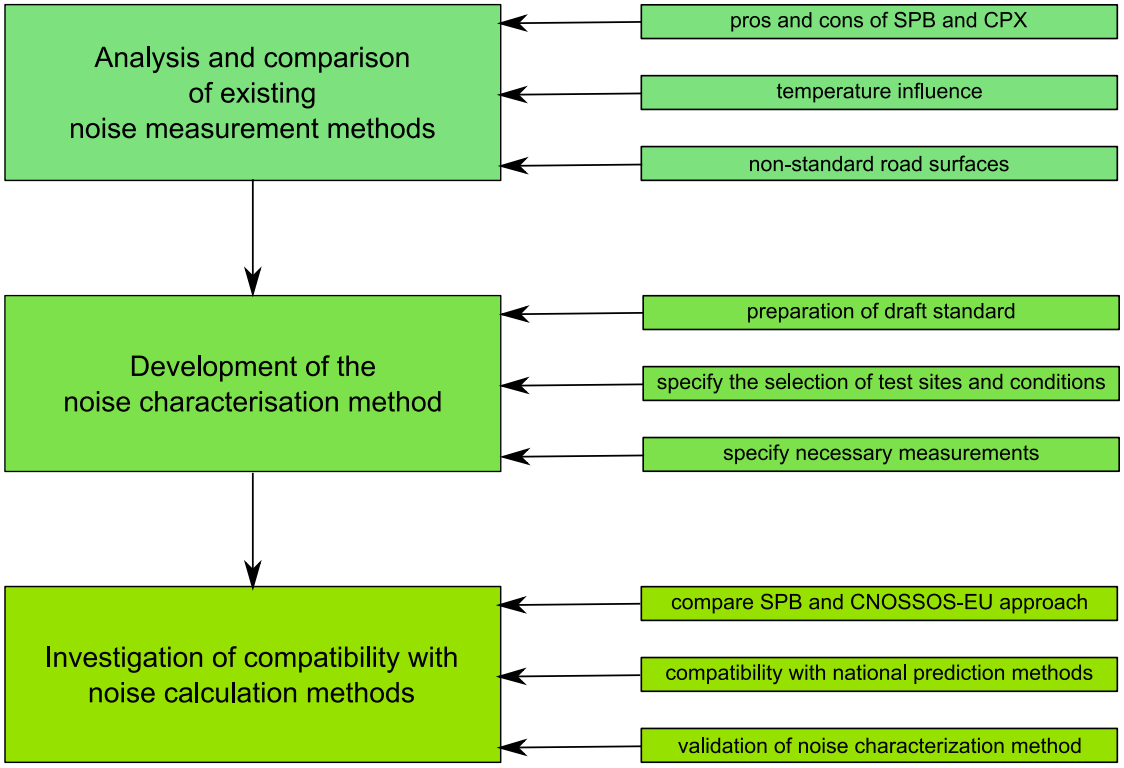

Figure 2 – Development process of the noise characterization method

Another important aspect in studying the two available methods is their correlation, advantages/disadvantages, problems, uncertainties, and their performance for non-standard pavement textures. The latter may be, for example, tined, ground or polished surfaces, other directional textures, poroelastic surfaces, and surfaces based on extremely small maximum aggregate sizes. The use of texture indicators to harmonize and/or supplement the methods will be studied.

3.2 Compatibility with CNOSSOS-EU and national noise calculation methods

National noise calculation methods in Europe currently differ in their complexity to take different road surface types into account. In the road traffic noise part of the Common Noise Assessment Methods in Europe (CNOSSOS-EU), the effect of the road surface on road noise emission is introduced in the calculation through a correction factor, the determination of which is to be defined in the coming implementation phase of CNOSSOS-EU. However, proposals have been considered, based on the outputs of the HARMONOISE and IMAGINE project, in which SEL (Sound Exposure Level) indicators are measured instead of L_{Amax} and at a 3 m high position instead of 1.2 m in the SPB method. Furthermore, this correction factor is intended to represent the noise performance not only in new condition but also over the lifetime of the pavement. There is a need to check the equivalence or at least the consistency between indicators and approaches. A comparison of SPB, CPX and CNOSSOS-EU approaches is necessary, as well as an identification of possible relationships. Also, to minimise barriers for future implementation, the compatibility with existing national prediction methods has to be considered. As a final step in this part of ROSANNE, measurements will be carried out in the future to verify the applicability of the characterization method developed.

4. CONCLUSION

In this paper, the currently ongoing EU FP7 project ROSANNE is presented. One of its main goals is to develop and harmonise measurement methods for skid resistance, noise emission and rolling resistance. The harmonised measurement framework for describing the noise emission of road surfaces will be based on the existing methods described in ISO 11819-1 and/or ISO/DIS 11819-2. Final remaining technical issues of these measurement methods, such as the temperature influence and reference tyres, will be solved during the project in close cooperation with the concerned ISO and CEN working groups. Special focus will be laid on its compatibility with the Common Noise Assessment Methods in Europe (CNOSSOS-EU) and national noise calculation methods.

ROSANNE started in November 2013 and some measurements have already been made, but results are not available when this is written. The reader may find more information on the project website www.rosanneproject.eu.

ACKNOWLEDGEMENTS

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