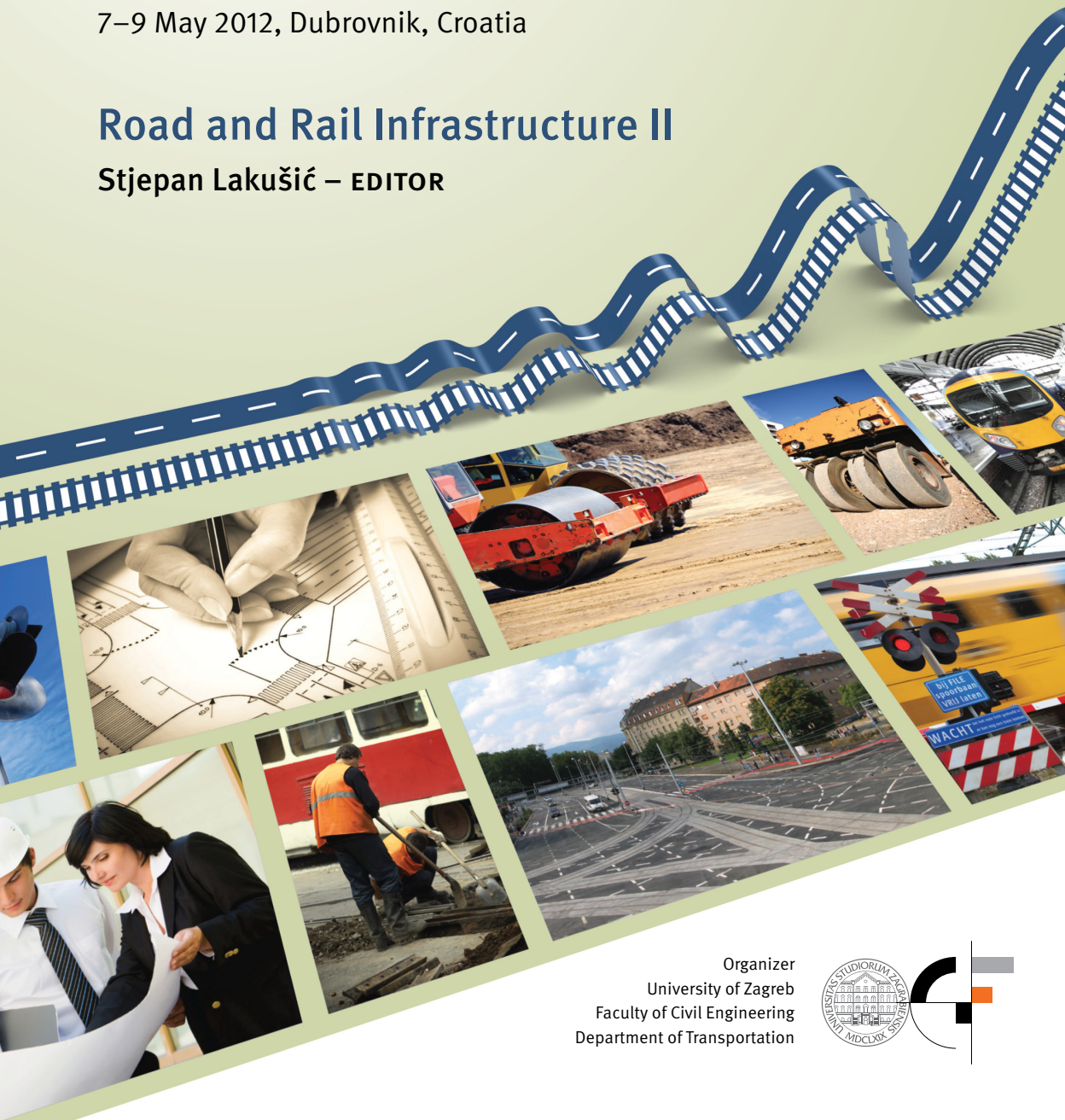
CETRA 2012

2nd International Conference on Road and Rail Infrastructure
7–9 May 2012, Dubrovnik, Croatia

Road and Rail Infrastructure II

Stjepan Lakušić – EDITOR



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LOW NOISE PAVEMENTS: AVAILABLE SOLUTIONS

Jean Paul Michaut
Colas, France

Abstract

For a long time, people complain about rolling noise. Since this time, the road pavement designers try to take into account the traffic noise level and mainly try to find solutions to decrease it. Knowing the complexity of noise is the first step that people have to know for finding the right solutions. Since the beginning of 80', Colas has worked on this field to find sustainable solutions. This presentation deals with some reminders about the rolling noise in order to understand the issue complexity then the different tools used for measuring this property. For this latter, it is reminded that noise measurement is not easy and we have to pay attention to the different used methods which can introduce some discrepancies when you compare the results and hence some difficulties. The history of the different low noise pavement is then illustrated by the beginning from the porous asphalt to the latest generation of asphalt concrete wearing course. One of the problems we have to solve is not only to decrease the noise but we also have to maintain high level of skid resistance. Some solutions are presented allowing gaining from 3 to 9 dB (A) in specific conditions in comparison with traditional wearing courses by keeping high level of skid resistance. Finally, it is concluded that from the point of view of road contractors, it is not possible to decrease more the rolling noise and that new solutions have to be found by the car or tyre manufacturers.

Keywords: rolling noise, noise, pavement

1 Introduction

For a long time, people complain about rolling noise. Since this time, the road pavement designers try to take into account the traffic noise level and mainly try to find solutions to decrease it. Knowing the complexity of noise is the first step that people have to know for finding the right solutions and that's why some reminders are presented below.

2 Noise reminders

Noise is a quick variation of atmospheric pressure in time. It's characterized by frequency and intensity and measured by acoustic pressure. The range level goes from 10 dB (A) which is absolute silence to 120 dB (A) for plane engine. When you are exposed to this level, you become deaf. Then you have to remember that acoustic pressure is the difference between atmospheric and sudden pressure and the noise level is a log function of acoustic pressure.
You may not forget that reflecting soil increases noise propagation, absorbing soil decreases noise propagation and that the noise addition is different. Just for illustrating it, here is an example:

$$60 \text{ dB (A)} + 60 \text{ dB (A)} = 63 \text{ dB (A)}$$

There are other properties for noise measurement such as mask effect, noise multiplication, wind and temperature which can affect the measured value. Sometime for assessing the noise in town, Equivalent Energizing Level is used.

3 Noise measurements

For rolling noise, numerous researches have been lead, firstly from the car manufacturer and then the tyre manufacturer and at last the road manufacturer. We now know that the rolling noise becomes dominant when the speed is greater than 50km/h and more. We don't come back on the different phenomenon causing the rolling noise, numerous documents have been issued concerning the physical and mechanical causes that generate noise from motors, the movement of mechanical parts and tire/pavement interaction.
For measuring it, there are different standards; some of them are European and other not. Among these methods there are statistical by pass method according to the ISO 11819-1 (Figure 1), close proximity method with different equipment (trailer or tyre car measurement) or laboratory measurement (Figure 2).

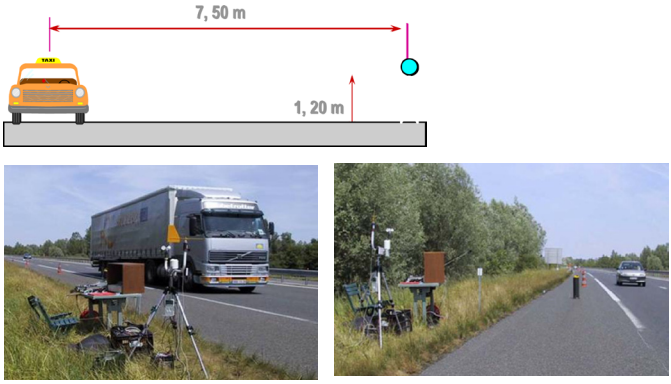

Figure 1 Statistical Bypass method

Figure 2 Close proximity method

Before speaking about rolling noise and its values, we have to keep in mind that noise depends on numerous factors such as: speed, temperature, wind, humidity, environment conditions (trees, safety barrier, etc.) and the measurement method. That's why we have to take care when we compare the values obtained to be sure to have the same test conditions.

4 How to decrease the rolling noise?

First of all, we can get some lesson out of the first observations from porous asphalt. This particular wearing course was developed to reduce the water spray and aquaplaning phenomenon due to rain and hence to improve the driver safety. At this time we observed rolling noise reduction. This improvement was mainly due to the high porosity (void content) in this layer.
The first lessons from Porous asphalt were:
· noise reduction round 3 dB(A) when compared to traditional asphalt concrete by statistical bypass method,
· clogging problem,
· small aggregates.

With these previous data, for the noise–reducing formulation, the mix design phase is extremely important, especially in terms of optimizing air void content in situ and verifying water content. Adsorption characteristics then come into play, and their evaluation is not part of current mix design practice and that's why some specific equipment for measuring noise in laboratory is necessary (Kundt tube for example).
Following the porous asphalt development and in order to improve the main properties double layer porous asphalt was developed. The main conclusions from this surface were:
· Double–layer porous asphalt reduces noise significantly as both engine and tyre/road noise is reduced by up to 6,5 dB in the year 0.
· The best and most durable solution was PA 8 as the top layer and DA16 or DA22 as the bottom layer. Here the noise–reduction effect was kept for 7 years (from 4,6 dB in the year 0 to 2,0 dB in the year 7)
· Cleaning with high–pressure water jetting once a year is needed
· The surface structure is sensitive to sideway forces from tyres on turning vehicles in crossings etc.
· It is relatively expensive compared to other wearing courses and requires a lot of planning and maintenance.

4.1 First generation

For having good rolling noise wearing course, one have to choose:
· small grading size,
· high void content,
· layer thickness, etc.
but by keeping for the surface characteristics a high level of skid resistance, a good durability, good mechanical performances such as rutting and shearing resistances.
According to this, specific wearing courses were developed for satisfying these points and we now find thin and ultra thin asphalt concrete, open grade asphalt concrete, stone mastic asphalt, etc. These formulations are mainly based on a open surface texture and small amount of connecting voids. Furthermore, European research (SILVIA project) was lead on rolling noise and the main findings were the following for avoiding noise from:
· air pumping: open surface texture,
· tyre vibration: very even surface, small maximum aggregate size,
· and elastic pavement.

According to these researches, the identity picture for this low rolling noise wearing course was to have the following properties:
· Thin or very thin asphalt concrete (from 2 to 4 cm thick),
· 0/6 grading
· Modified binder

And the gain was around from 2 to 4 dB (A) at 90km/h and for a temperature of 20°C compared to a traditional asphalt concrete. That was the first generation of low rolling noise pavement.

4.2 Second generation

Then the second generation is appeared by taking into account the last researches. The solution was also to use thin or very thin asphalt concrete but by optimizing or increasing the skid resistance and lowering the rolling noise as much as possible. As said before, the asphalt concrete formulation is essential and you have to choose aggregates with good intrinsic properties (shape and hardness), by increasing the number of contact points with tyre for decreasing the noise impact , by keeping good surface drainability by macro texture and finally, to increase the noise absorption by void content (small and winding voids).
One of the Colas products meets these requirements: it is called Rugosoft. The main properties for this special wearing course are:

- fine grading (from 6 to 8 mm according the available fraction sizes in European countries)
- continuous grading curve which is completely different from the previous solutions for which gaps graded grading curve were asked,
- with high proportion of small aggregates
- with modified binder
- with void content between 20 and 25%.

On the following Figure 3, the skid resistance has been measured and compared with very thin asphalt concrete.

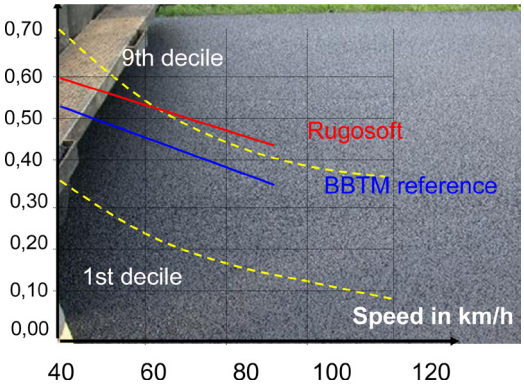

Figure 3 Skid resistance level – longitudinal braking force coefficient (PIARC tyre: RN 76 after 3 years)

With this kind of asphalt concrete the noise decrease is around 4 to 6 dB (A) at 90km/h and 20°C by using Statistical Bypass method. The noise performances are on the same level as double layer porous asphalt but it's a easier and cheaper technique.

4.3 Third generation

For improving the previous performances, we decided to launch new research and we arrive at the third generation of low rolling noise pavement. For this research in the laboratory, we have used the Kundt tube. Due to these studies, we found the following conclusions:

- fine grading 0/4 mm,
- highly modified bitumen,
- an optimized grading curve for a maximum acoustic absorption.

This new product (Nanosoft) has good properties and also good skid resistance (Figure 4). According to the French data, this product has the lowest value obtained by the statistical by pass method (90km/h and 20°C) as we can see on Figure 5.

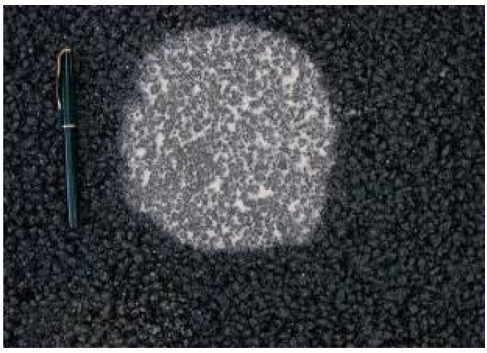

Figure 4 Nanosoft PMT : 0.7 to 0.8 mm

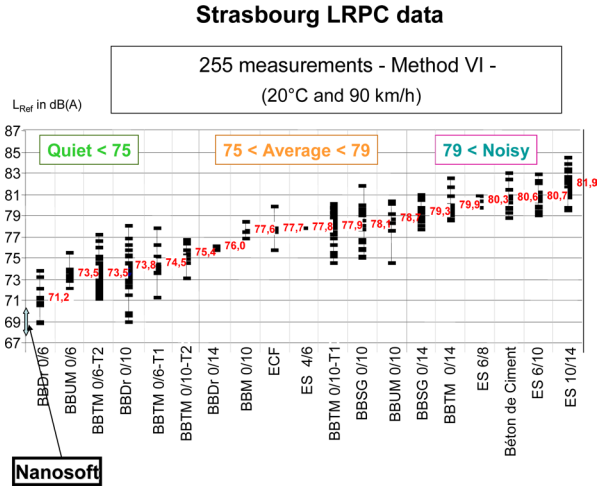

Figure 5 Nanosoft Noise measurement

5 Conclusions

With the different products developed, the gain for rolling noise can go down from 2 or 3 dB (A) with porous asphalt and the first generation of low noise asphalt concrete to 7 or 9 dB (A) for the third generation in comparison with traditional asphalt concrete wearing course. One other problem we have to keep in mind is not only to decrease the noise but we have to maintain high level of skid resistance. Solutions which have been presented also give a high level of skid resistance. From the research, we can conclude from the point of view of road contractors, that it is not possible to decrease more the rolling noise and that new solutions have to be found through the car or tyre manufacturers.