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Experiment of low-noise road surfaces on the Paris ring-road

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ABSTRACT

At the end of June 2012, the City of Paris started up an experiment on a 200 m portion of the Paris ring-road so as to test the relevance of low-noise road surfaces (Rugosoft® and Nanosoft® produced by Colas company) and its sustainability over time from an acoustic as well as from a mechanical point of view, in a context of great constraints related to the large number of vehicles using the ring-road daily (over 1,2 million vehicles with up to 270,000 vehicles per day in some places).

Within the framework of the project HARMONICA [2] supported by the European program LIFE+, Bruitparif has set up five noise measurement stations so as to monitor the acoustic effectiveness of the product tested over a long period. The first station was set up on the central reservation, the three next ones are on the front of buildings adjacent to the ring-road at the level of the experimental section and the last one was positioned outside the perimeter of experiment so as to be used as a control station. In addition to this, digital audio recordings were made in front of buildings and inside a moving vehicle. The results obtained three months after the beginning of this experiment will be presented and discussed in this paper. For the oral presentation, they will be completed with updated results obtained during the summer of 2013, one year after the beginning of this experiment.

1. CONTEXT

The reduction of the intense noise generated by traffic on the ring-road necessarily involves the combination of several measures. Among the measures that can be considered, laying low-noise road surfaces appears to be a promising solution to deal with the problem at its source.

The City of Paris and Bruitparif have thus proposed to start up an experiment over a portion of the ring-road so as to test the relevance of this type of solution and its sustainability over time from an acoustic as well as from a mechanical point of view, in a context of great constraints related to the large number of vehicles using the ring-road daily (over 1,2 million vehicles with up to 270,000 vehicles per day in some places).

The portion of the ring-road selected for the experiment is a 200 m section located on the site of the Great Urban Renewal Project at Porte de Vincennes, between Pont de Lagny and the interchange at Porte de Vincennes. From 25th to 29th June 2012, the services of the Road and Traffic Department of the City of Paris and Colas laid the products Rugosoft® and Nanosoft® on both traffic lanes of this

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section (Rugosoft® on the inner ring-road and Nanosoft® on the outer ring-road) as well as on the feeder roads.

Within the framework of the project HARMONICA [2] supported by the European program LIFE+, Bruitparif has set up five noise measurement stations so as to monitor the acoustic effectiveness of the product tested. The first station was set up on the central reservation (directly next to the traffic), the next three ones are on the front of buildings adjacent to the ring-road at the level of the experimental section, and the last one was positioned outside the perimeter of the experiment so as to be used as a control station.

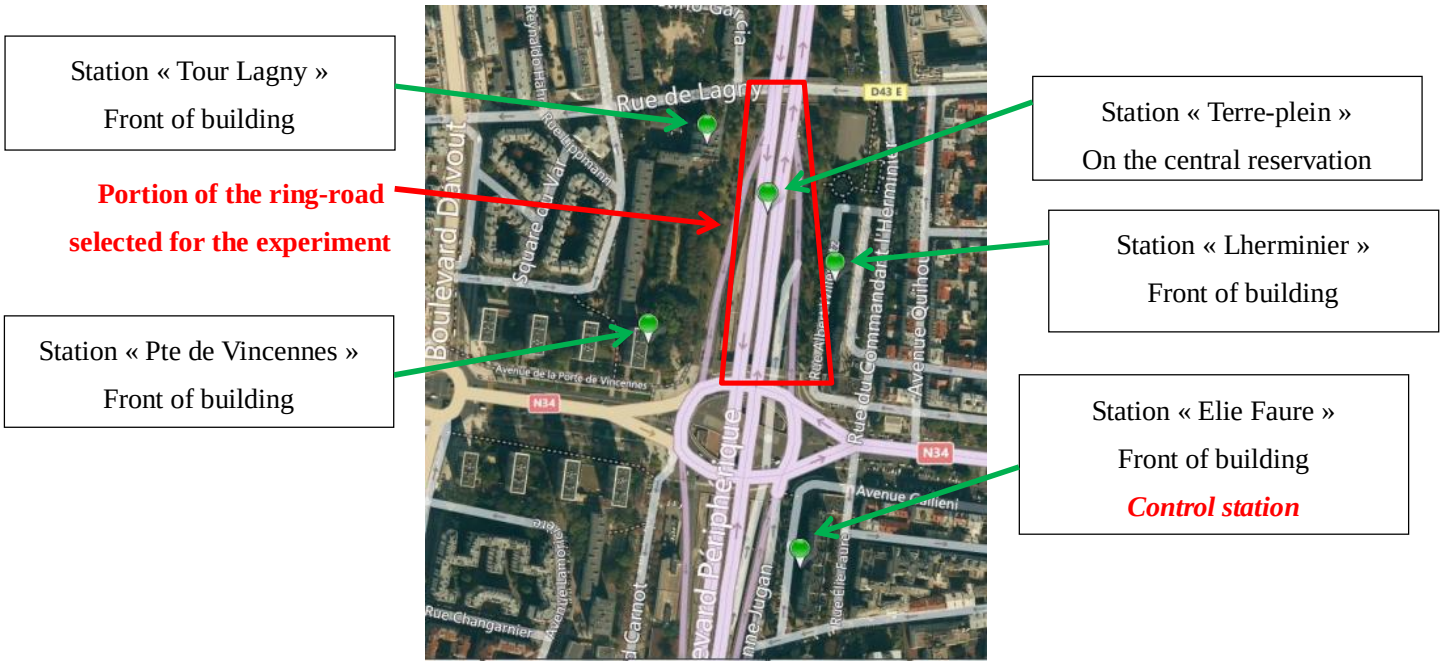

Figure 1 – Location of noise monitoring terminals.

For direct access to the results of the noise monitoring device at Porte de Vincennes, please use the real-time public noise measurement display, available on the internet via Bruitparif's website: http://rumeur.bruitparif.fr

Figure 2 – Real time measurements public display from Bruitparif (http://rumeur.bruitparif.fr).

In addition to this, digital audio recordings were made in front of buildings (see Figure 3) and inside a moving vehicle thanks to a device capable of recording noise levels and reproducing them as they are perceived by the human ear (SquadrigaII®). This has allowed to document the improvement in terms of acoustic comfort for residents as well as drivers.

Figure 3 – A Bruitparif noise technician making digital audio recordings in front of buildings.

The results obtained three months after the beginning of this experiment will be presented and discussed in this paper. For the oral presentation, they will be completed with updated results obtained during the summer of 2013, one year after the beginning of this experiment.
The results of this experiment will also be published and shared with other best practices examples on the next noise abatement actions database available on the final web portal of the HARMONICA [2] project "noiseineu" online at the end of 2013 : http//www.noiseineu.com

2. A SIGNIFICANT NOISE DECREASE

A first evaluation was conducted three months after the road surface was changed.

The noise reduction at its source was 7.5 dB(A) on average in the results obtained on the central reservation (see Figure 4). Such a noise decrease is quite significant and corresponds to what could be obtained by dividing the traffic flow by six (all other conditions being equal) (see Figure 6).

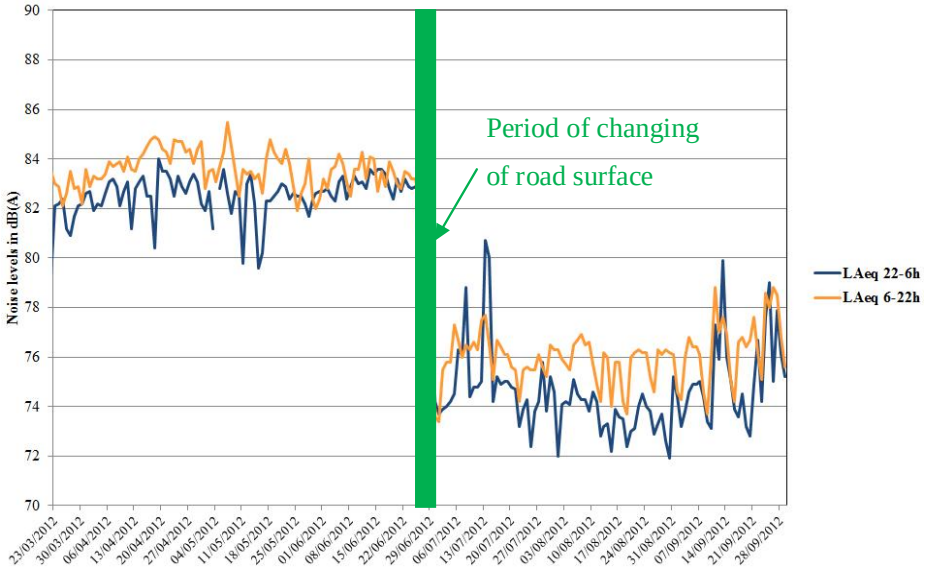

Figure 4 – Decrease of daytime and night-time noise levels

next to source (central reservation) after the changing of road surface.

On the front of residential buildings, noise levels have fallen by 2.2 to 4.3 dB(A) on average, depending on the location (see Figure 5). The improvements obtained correspond to what could be gained by reducing traffic by 30 to 70 % (see Figure 6). This improvement does not translate, however, into a proportional improvement in terms of hearing sensation. Indeed, it should be reminded that a 3 dB(A) decrease is perceptible, but a decrease of around 5 dB(A) must be reached to clearly perceive a difference in the noise level, and a decrease of about 10 dB(A) to feel that the noise has been divided by two (see Figure 6).

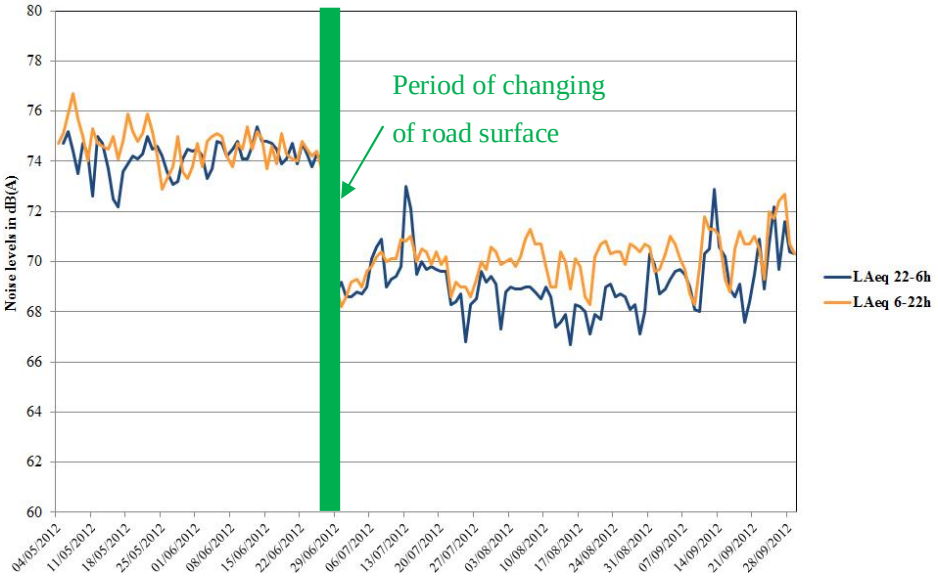

Figure 5 – Decrease of day-time and night-time noise levels
in front of the Lherminier building after changing the road surface.

The buildings that saw the greatest improvement were those exposed mainly to the noise generated by the ring-road and located closest to the experimental section: Tour de Lagny (-4.1 dB(A) on average) and the Lherminier building (-4.3 dB(A) on average).

The station located at the level of the building at Porte de Vincennes has benefited from a lesser reduction in noise levels (-2.2 dB(A) on average), as its exposure to noise combines the noise generated by the ring-road and that generated by Avenue de la Porte de Vincennes.

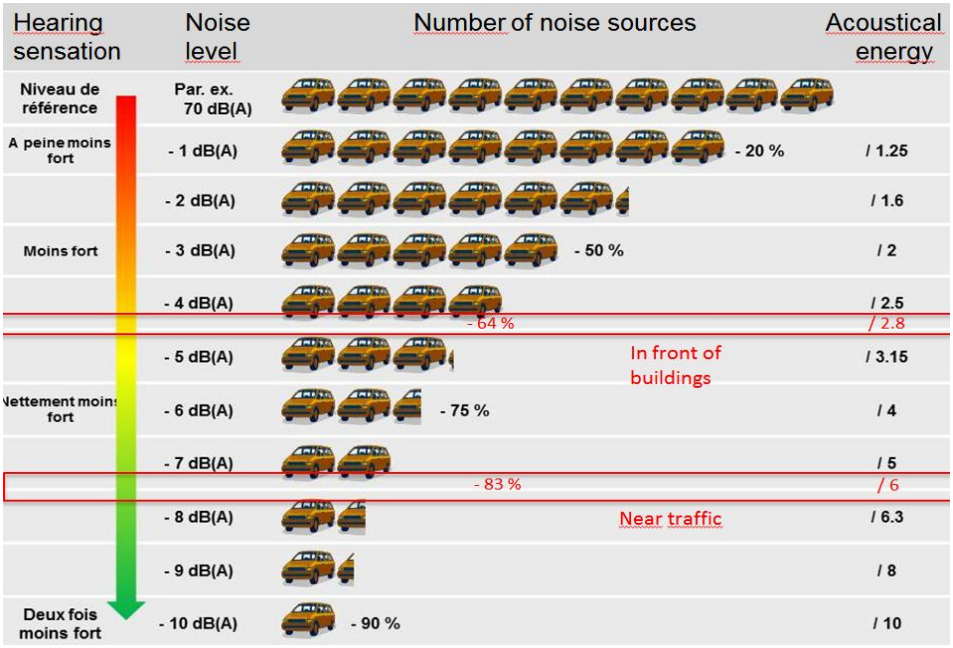

Figure 6 – Relationships between noise level reduction, hearing sensation and acoustical energy.

3. NOISE EXPOSURE LEVELS STILL HIGH

In spite of such significant improvement, the situation in terms of exposure to noise for residents closest to the ring-road remains unsatisfactory. The regulatory threshold values are still exceeded by 2 to 6 dB(A) for the night-time regulatory indicators (the French regulatory threshold is 65 dB(A)). On the other hand, the situation is less critical for day-time levels since two out of three stations in "residential" locations now record LAeq levels (6-22h) that are below or very close to the French regulatory threshold of 70 dB(A).

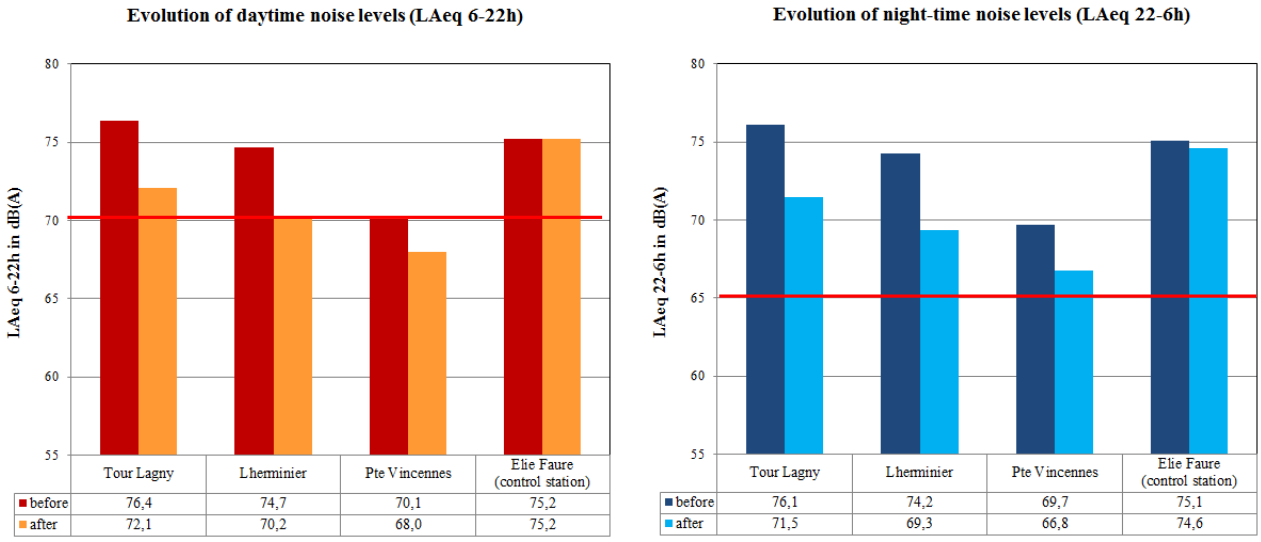

Figure 7 - Evolution of day-time and night-time noise levels in residential locations.

4. A LESS AGGRESSIVE SOUND

When the frequential distribution of the gains obtained is analyzed, it can be noted that the greatest decreases (up to -7 dB in residential locations) typically correspond to a frequency range between 1000 and 2000 Hz (see Figure 8). It should be recalled that such a frequency corresponds both to the frequency range that the ear is most sensitive to and also to the conversational range. Decreasing the noise levels generated by traffic in these frequencies therefore improves the hearing sensation (the noise sounds less aggressive, as it were) and improves the intelligibility of conversations by diminishing the masking effect.

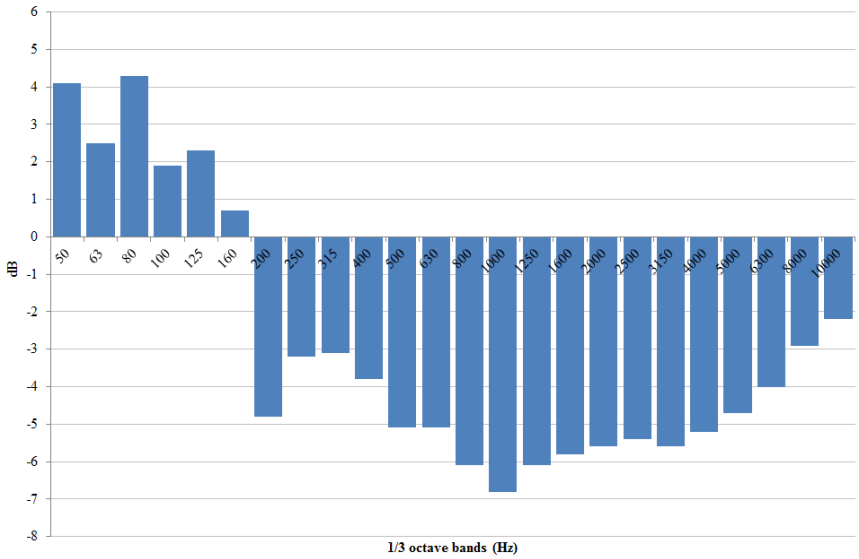

Figure 8 – Decrease of noise levels per 1/3 octave bands in residential locations after the changing of road surface.

For drivers, the phenomenon is quite perceptible with a muffled and duller sound inside the car when driving over the new road surfaces. The differences are greater for Nanosoft™ (around -10 to -12 dB in the frequency range between 1000 and 2000 Hz) than for Rugosoft™ (around -8 to -10 dB in the frequency range between 1000 and 2000 Hz.

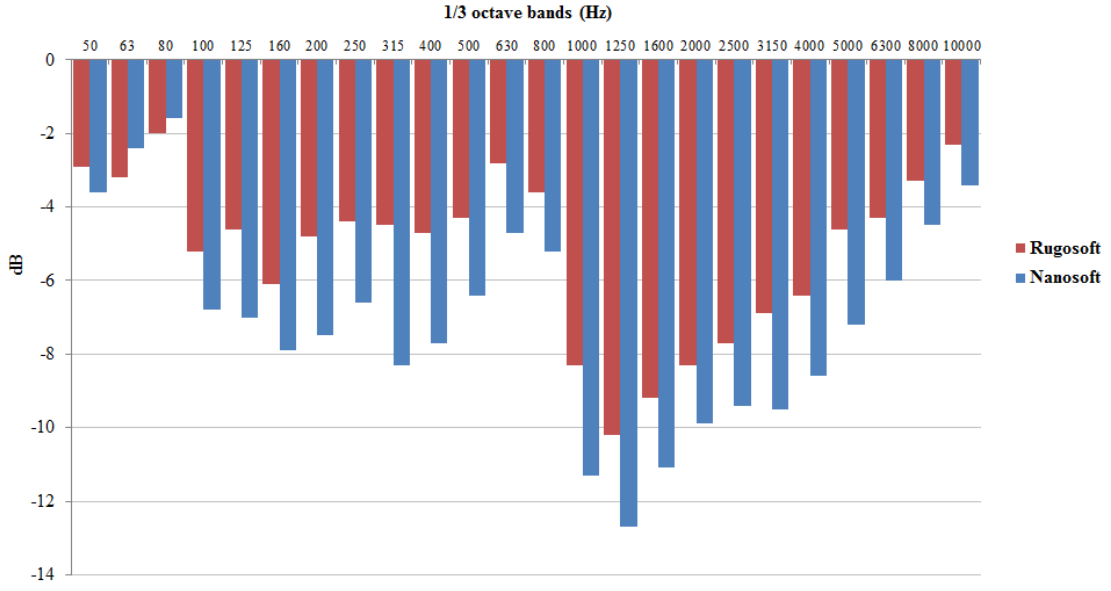

Figure 9 – Decrease of noise levels per 1/3 octave bands for drivers due to the replacement of road surfaces with low-noise road surfaces (Nanosoft™ and Rugosoft™).

5. DECREASE IN NOISE LEVELS WHATEVER THE TRAFFIC CONDITIONS

Another interesting element is that the decrease in noise levels appears whatever the day (business day or at the week-end) and whatever the time of day (see Figure 10). Depending on the time of day, a reduction of between 5.8 and 9.9 dB(A) can be observed in the location near the source of noise (on the central reservation) and a reduction of between 2.8 and 5.9 dB(A) in residential locations (on the front of the Lherminier building and Tour de Lagny).

The lowest decreases can be observed at times of significant traffic congestion (around 9 am on week-days days or 7 pm at week-ends). Nevertheless, the improvement remains significant even in such conditions (by about -5.6 dB(A) at the source and -3 dB(A) in residential locations), which tends to show that the road surfaces remain effective even when traffic speed is low and that they can even be effective in reducing engine noise.

Furthermore, the greatest decrease occurs at times when noise levels are highest, which is particularly positive. It can be noticed, for example, that between 6 and 6.30 am on week-days, at a time when studies show that noise levels are at their highest, the noise levels are reduced by 8.5 dB(A) in locations close to the source, and by 4.9 dB(A) and 5.4 dB(A) in residential locations at the level of Tour de Lagny and the L'Herminier building respectively.

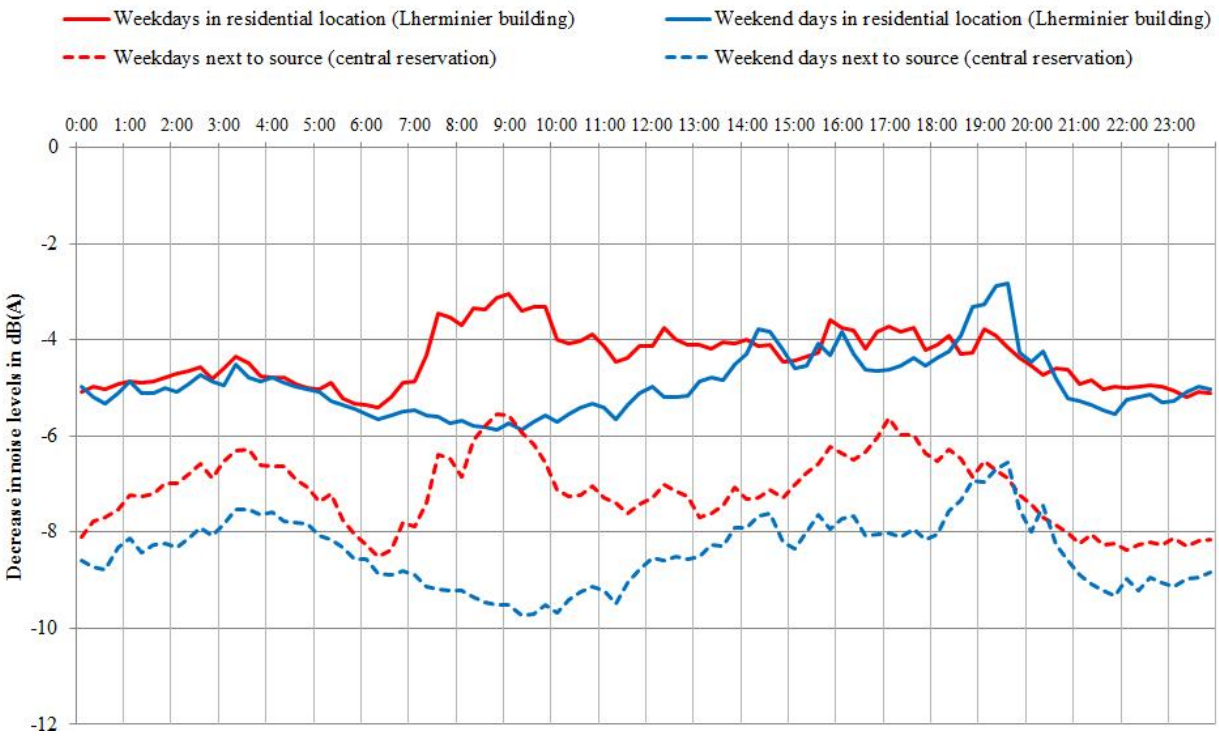

Figure 10 - Average decrease in noise levels after changing road surfaces depending on the time and type of day.

6. CONCLUSION

This first evaluation after three months therefore provides very encouraging results as regards the effectiveness of low-noise road surfaces for reducing the noise exposure of residents living close to the ring-road. It reveals, however, that complementary actions must be considered in order to reach the regulatory values. Moreover, it will be necessary to continue analysis and monitoring for several months in order to check whether the acoustical performance and the mechanical qualities of the new road surfaces are durable enough to cope with the heavy traffic on the ring-road.

Updated results will be obtained during the summer of 2013, one year after the beginning of the experiment.

REFERENCES

[1] Bruitparif report about the results of the experiment (in French) : “Mesure du bruit Bd Périphérique Pte de Vincennes – Bilan à 3 mois de l’effet acoustique de la mise en oeuvre de nouveaux revêtements de chaussée”, oct. 2012

[2] Harmonica website : http://www.harmonica-project.eu/en