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NOISE CONTROL FOR A BETTER ENVIRONMENT

First results of activities carried out in the pilot area of Life MONZA project

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ABSTRACT

One of the main goal of the LIFE MONZA project, which started in September 2016, is to reduce the average noise levels present in the Libertà district by means of both top-down (creation of a limited traffic zone to forbid the access to trucks, limitation of vehicles speed, lanes-width reduction and pedestrian crossing introduction, substitution of the current asphalt with a silent one) and encouraged bottom up actions (people involvement, ideas contest among students, pedibus service, etc).
In this paper, first results of activities carried out in the mentioned pilot area of Life Monza project are illustrated.

Keywords: environmental noise, noise management, low noise paving, low cost sensors, noise monitoring

I-INCE Classification of Subject Number: 52

1. INTRODUCTION

Currently, noise is considered as one of the most dangerous pollutants affecting urban realities. Important contributes to manage this issue has been given by some concluded European projects such as LIFE+2010 QUADMAP, LIFE+2008 HUSH and LIFE+2009 NADIA [1,2]. As an additional contribution, the LIFE MONZA project (Methodologies fOr Noise low emission Zones introduction And management - LIFE15 ENV/ IT/000586) aims at developing an easy-replicable method and related guidelines,

for the identification and the management of the Noise Low Emission Zone (Noise LEZ), an urban area subject to traffic restrictions, whose impacts and benefits regarding noise issues will be analysed and tested in the pilot area of the city of Monza, located in Northern Italy.

In the LIFE MONZA project new management actions tailored for Noise LEZ and low cost monitoring sensors [3,4] have been experienced in a pilot area of the city of Monza.

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2. PROGRESS OF THE PROJECT

The pilot area selected in the framework of the LIFE MONZA project consists of the Libertà district of the city of Monza shown in Figure 1.

Figure 1. Perimeter of the pilot area ("Libertà" district, city of Monza)

Significant average levels of noise pollution affect many citizens so that Libertà district is identified as a hotspot in the Action Plan of the city of Monza.

With the aim to reduce the noise pollution in the pilot area two main interventions have been designed and implemented for the Libertà street: the laying of new low-noise paving and the closing of the road to the heavy vehicles.

2.1 Main implemented interventions

The low-noise asphalt represents the main instrument for the decrease, on large scale, of the traffic noise through interventions at the noise source and today several technologies are available based of composition, used materials and field of use.

For the laying of the asphalt, the typology "*Dense graded at optimized weaving*" has been chosen, which guarantees results of 3-4 dB(A) in term of acoustic abatement and an efficiency period about five years from the laying. This road surface has already

been defined by “Progetto Leopoldo” whose results have been recognized by a deliberation of Regione Toscana in 2013 [5]. Progetto Leopoldo aimed to define a guideline for the design, building, control and maintenance of ordinary viability in Tuscany. This guideline allows to identify technologies, materials and kinds of interventions with the scope to improve the safety of the circulation and at the same time guarantees requests of eco-compatibility and duration. In the sample studied at Lucca, four years after the works a reduction of 5 dB(A) has been measured. In Figure 2 the section of Viale Libertà interested by the new asphalt laying is shown. In this road the work has foreseen the removal of the old road surface and the laying of 4 cm of link layer of BINDER and following 4 cm of use-surface in DENSE GRADED.

The works to lay the new low-noise asphalt has started on Monday 17 September 2018 and finished on Saturday 22.

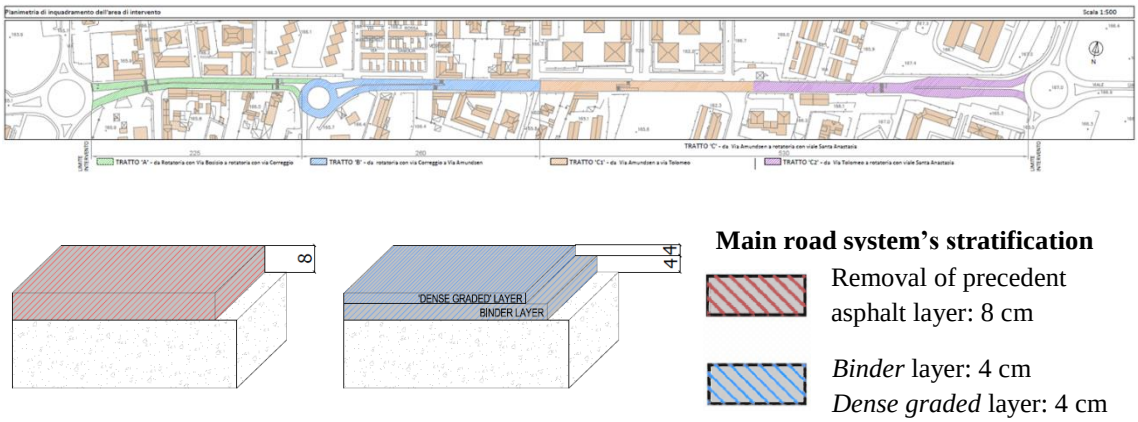

Figure 2. Detail design of interventions in Viale Libertà

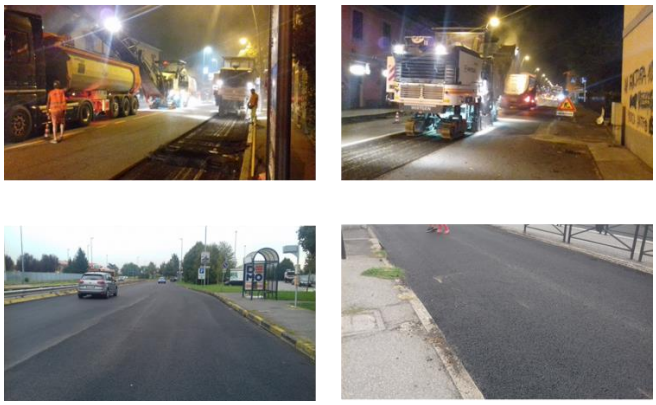

Figure 3. Works for the laying of new low-noise road surface in Viale Libertà (September 2018)

Regarding the limitations of the traffic in the pilot area of Libertà district, the first one is already underway since 21 January 2019. For the first six months (January-July 2019) the access of the vehicles larger than 3,5 ton will be forbidden, while in the following three months (July- October 2019) the limitation will regard only the vehicles heavier than 7,5 ton.

3. NOISE MONITORING IN THE PILOT AREA

Among the activities carried out in the LIFE MONZA project, the noise monitoring has been planned in the ante and post operam scenario, by using of both the

class I instrumentation and a new low cost monitoring sensor network developed into the project [3, 4], in order to study the efficiency of interventions planned to reduce the traffic noise in this area. Moreover, some counter-traffic units were put in place to monitor road traffic flows.

In the Figure 4 the noise monitoring positions are shown, together with the positions of counter-traffic control units and low-cost sensors (*Smart Noise Monitoring System* "SNMS") to evaluate noise pollution both in ante and post scenario.

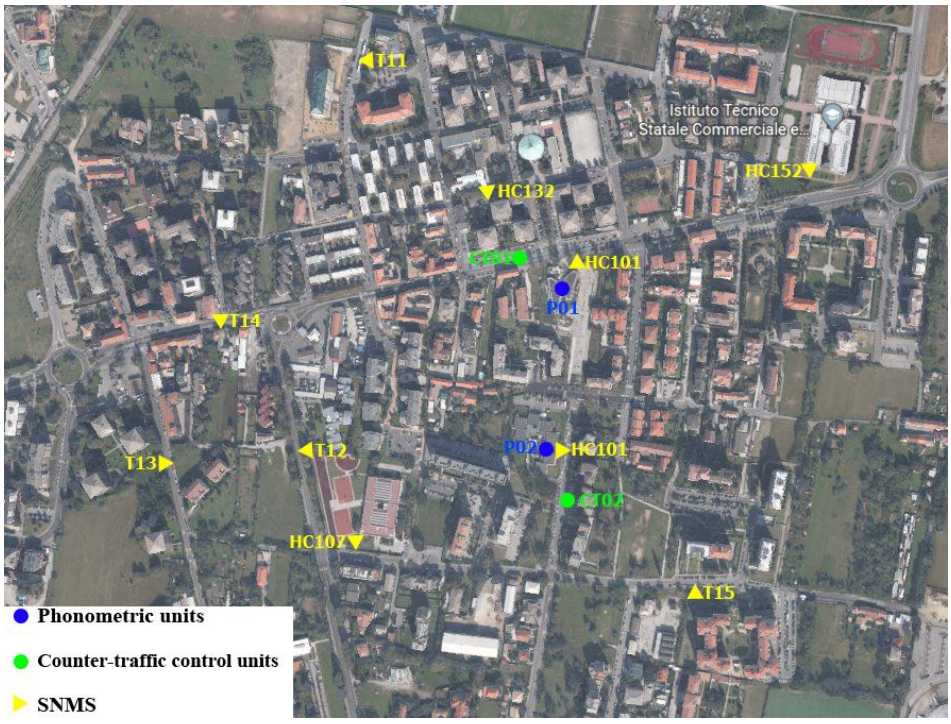

Figure 4. Different kind of measuring systems and related positions to monitoring noise in the pilot area.

3.1 Smart Noise Monitoring System (SNMS)

The Smart Noise Monitoring System (SNMS) network is meant to adequately cover the pilot area and the different types of roads. As illustrated in Figure 4, 10 monitoring stations have been installed in the pilot area. In particular, 3 microphones have been placed along Viale Libertà, the main street where the traffic flow mix is expected to mainly change from ante to post-operam scenario. The other microphones have been uniformly distributed along other streets belonging to the pilot area. The SNMS technical specifications were defined in [6] keeping in mind the aim of a long-term monitoring of acoustic parameters. These are expected to be useful to understand the variability of acoustic climate in the pilot area with mainly reference to the overall A-weighted continuous equivalent sound pressure level.

The 10 prototypes of the monitoring stations have been installed in the pilot area in June 2017 and, at the end of the LIFE MONZA project, will be given for free to the city of Monza that will take care of using them for monitoring activities in the three years after LIFE period.

3.2 Class I Noise Monitoring System

For the correct determination of the levels expected in front of the receptors, an ante-operam and post-operam monitoring have been planned at some specifically

identified receivers. In particular, it was planned to carry out weekly measurement campaigns in both the Spring/Summer period and the Autumn/Winter period relating to both noise measurements and traffic flows. The instrumentation used to perform noise measurements complied with the class I requirements according to regulations IEC 651 – EN 60651 and IEC 804 – EN 60804.

Currently, only the noise monitoring in the Autumn/Winter period is available to be analysed for ante and post operam scenarios. In particular, the ante-operam monitoring was carried out in the period between Monday 20 and Monday 27 November 2017, while the post-operam monitoring was carried out between Monday 21 and Monday 28 January 2019. These noise monitoring campaigns consisted of long-term monitoring campaigns (one-week duration) and short-term monitoring campaigns (one-hour duration). In this paper only the results of long-term monitoring campaigns are shown.

In particular, the long-term monitoring campaign consists of a week noise monitoring and a week road-traffic counting in 2 positions located in external environment and in P01- Civic Centre and in P02- School Modigliani (see Figure 4). The microphones were placed on the roofs of the interested receivers, facing the roadway. The counter-traffic control units (CT01 and CT02) have been positioned on the roadside, whose results evidence the subdivision in light and heavy vehicles in the time slots subject to phonometric measurements.

4. RESULTS OBTAINED FROM THE SMART NOISE MONITORING SYSTEM

With reference of one sensor placed along Libertà street (Figure 4), HC101, in this chapter the results of the two interventions achieved in the Libertà district (new low-noise pavement's laying and limitation of heavy vehicles passage) will be illustrated.

This sensor has been placed in correspondence of the façade of the Civic Centre and the results take account of the façade's reflection.

In particular, Figure 5 shows the contribution of the new laying of low-noise asphalt in Viale Libertà: on the left of the graphic the A-weighted continuous equivalent sound pressure level, "L_{Aeq}", is reported for a week before the intervention, in the middle of the diagram the sound pressure level recorded during the laying is present and in the right of the graphic there is the time history starting trend to one month after the works, recorded for eighteen days. The month after the works was not considered for analysis because it is a necessary period for the settling of the paving. Focusing on these first elaboration data, it is possible to see a visible noise reduction due to the laying of the new low-noise road surface.

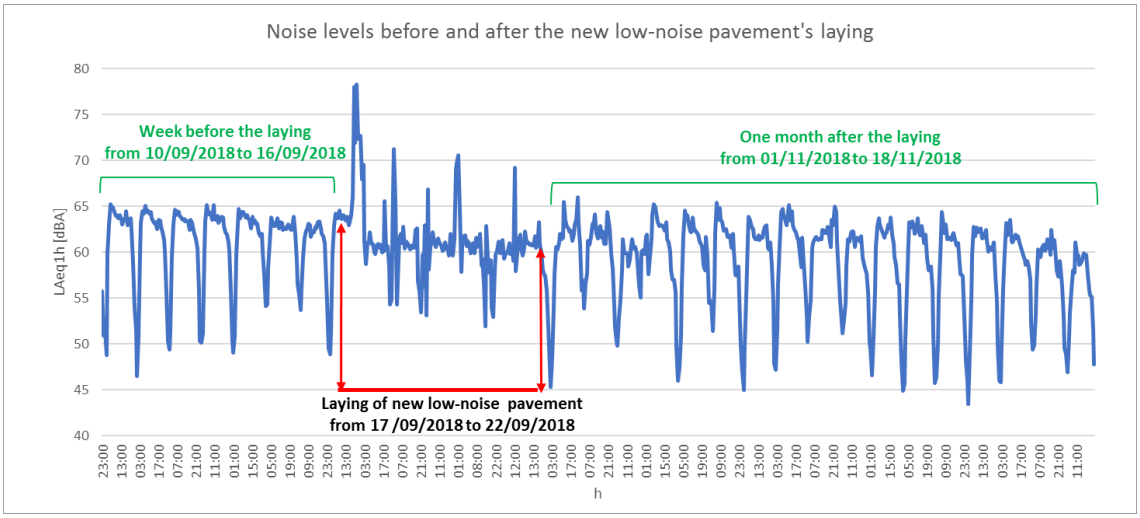

Figure 5. Noise levels recorded by the sensor HC101 before, during and after the laying of the new road surface

Furthermore, referring to the same sensor HC101, in Figure 6 the trend of noise levels in the week before and after the limitation of the passage for the vehicles larger than 3,5 ton (performed on 21st of January 2019), has been reported. However, in this case, the effect of this action is not clear visible on the time history of sound pressure level recorded.

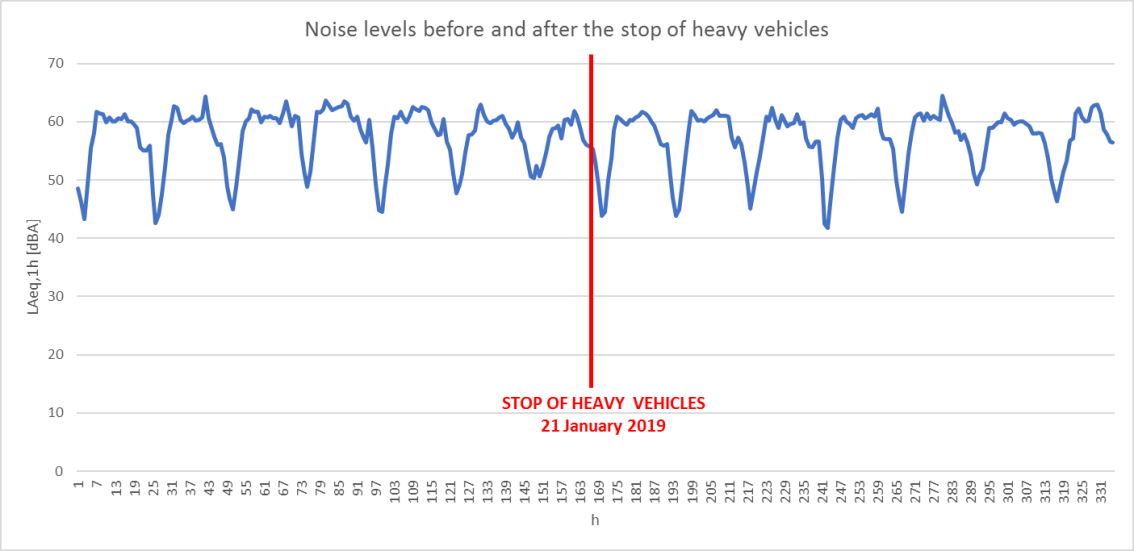

Figure 6. Noise levels recorded by the sensor HC101 before and after the stop of heavy vehicles

5. COMPARISON OF NOISE LEVELS IN ANTE AND POST OPERAM SCENARIOS

Referring to the long-term monitoring performed by using the class I instrumentation, taking as reference the position identified as P01 (Figure 4), located on the roof of the Civic Centre facing the Libertà street, the comparison between the monitoring activity carried out in November 2017 and in January 2019 has been made.

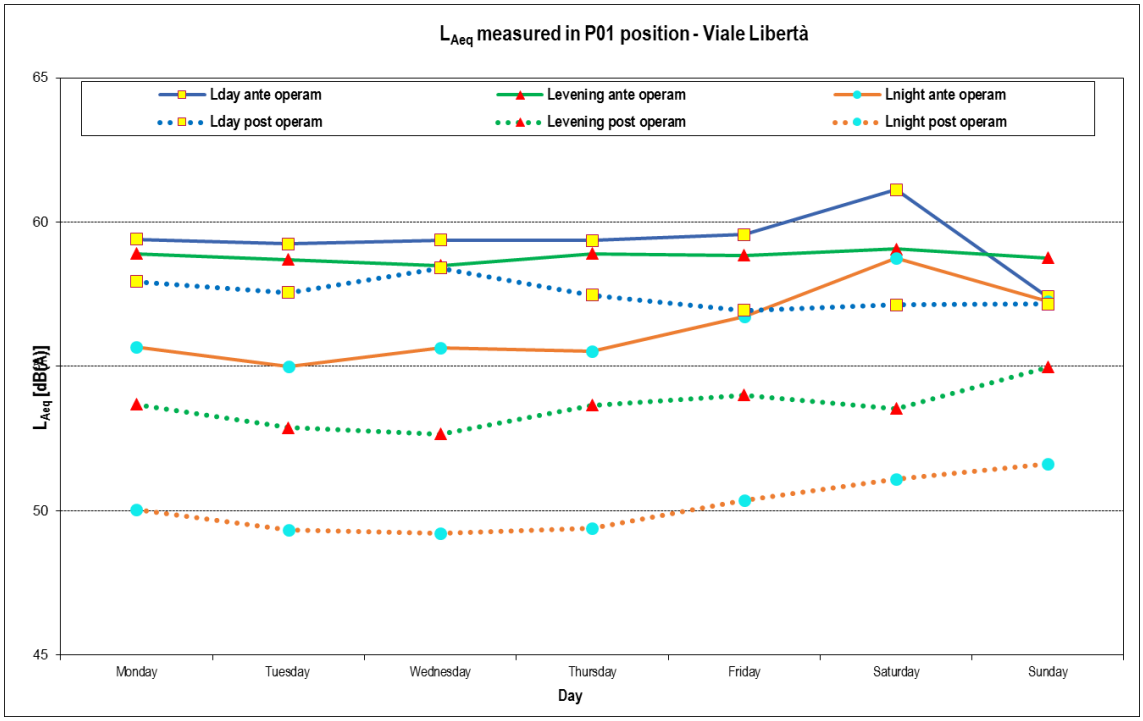

Figure 7. Comparison of sound pressure levels recorded in ante and post operam in the position of the Civic Centre P01

Referring to the traffic flow data, on the base of the road-traffic counting performed in the ante and post operam scenarios, it's possible to affirm that, in the time period "Day", there is a very good alignment between data of the ante and post-operam scenarios. Also in the "Evening" and "Night" periods the deviations of the traffic flows between ante and post-operam scenarios are of a small entity (lower than 10%). Finally, referring to heavy vehicles, in all the periods a reduction of the heavy vehicles in the order of 30% between the configuration ante and post-operam is appreciable.

This result confirm that the attenuation observed in the graphic in figure 7, in term of sound pressure level, is essentially due to the interventions realised.

In particular, a very good attenuation is obtained in the "Evening" and "Night" periods probably due to the presence, in these periods, of traffic flow moving in a fluid mode able to increase the performance of the low noise paving intervention.

6. COMPARISON OF NOISE LEVELS OBTAINED WITH CLASS I AND LOW-COST SENSORS

Such as shown in the following table 1, the results of the noise monitoring carried out in January 2019 highlight a same and constant difference, about 3 dB, between the sound pressure levels recorded by low-cost sensor and class I systems in all periods analysed (Day, Evening and Night time). This difference is caused by the different position of the microphones. This stability of results seem to make the low cost sensors usable for noise monitoring in the place of class I instrumentation.

Instead, in the measurements of November 2017 only in the "Night" period the difference cited above is equal to 3 dB, while in "Day" and "Evening" times there are bigger deviation probably due to the activities happened nearby of the entrance of Civic Centre and therefore near the sensor. In the light of these considerations, the results in "Day" and "Evening" periods haven't been use for the comparison of the results.

Table 1. Analysis of the results obtained for the acoustic descriptor L_{day}, $L_{evening}$ and L_{night} by the low-cost sensors and class I systems

	Period	**Lday (06-20) [dB]**	**Levening (20-22) [dB]**	**Lnight (22-06) [dB]**
Class I Instrumentation	Nov-17	59.5	58.8	56.5
Sensor HC101	Nov-17	64.6*	62.5*	59.2
	Difference	5.1	3.7	2.7
Class I Instrumentation	Jan-19	57.5	53.7	50.3
Sensor HC101	Jan-19	60.4	57.0	53.0
	Difference	2.9	3.3	2.7

Table 2. Comparison of the results obtained for the acoustic descriptor L_{day}, $L_{evening}$ and L_{night} between the two measurement systems used in the monitoring of the ante and post-operam

	Period	**Lday (06-20) [dB]**	**Levening (20-22) [dB]**	**Lnight (22-06) [dB]**
Class I Instrumentation	Nov-17	59.5	58.8	56.5
	Jan-19	57.5	53.7	50.3
	Difference	2	5.1	6.2
Sensor HC101	Nov-17	-	-	59.2
	Jan-19	-	-	53.0
	Difference	-	-	6.2

After comparing the results obtained in the monitoring of the ante and post-operam scenarios, we can conclude with the following considerations:

- in the “Evening” and “Night” periods, when there are passages of only light vehicles and the traffic is fluid, there is a great result because the intervention of low-noise laying mainly works on the rolling noise;
- in the “Day” period, when there isn’t fluid traffic with the presence of situations of “stop and go” due to a traffic light, the efficacy of the laying of road surface is lesser precisely because this kind of intervention principally works on the rolling noise.

6. CONCLUSION

In this paper, first results of activities carried out in the pilot area of Life Monza Project are illustrated.

As a conclusion of the performed analysis, the interventions realised in Viale Libertà of the city of Monza (new low-noise pavement’s laying and the limitation of the heavy vehicles passage for the means larger than 3,5 ton) provide very good results in terms of abatement of the traffic noise in the pilot area of LIFE Monza project.

In particular, in terms of noise monitoring with class I instrumentation, the reduction in terms of sound pressure levels measured in the “Day” period, between ante and post-operam, is equal to 2 dB. In the “Evening” and “Night” period this reduction is higher, until 6 dB in the night period.

Moreover, repeating the same analysis based on the low cost sensor, it is possible to observe an excellent alignment between the noise levels' difference obtained between the two different measurement systems.

After a comparison between the results obtained with instruments in class I and the Smart Noise Monitoring System (SNMS) it is possible to deduce that also the "low cost" monitoring sensors provide reliable data to evaluate the acoustic performance of interventions.

7. ACKNOWLEDGEMENTS

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