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LIFE SILENT: IMPLEMENTATION OF THE SOLUTIONS DEVELOPED IN THE PILOT SITE

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ABSTRACT

This paper shows LIFE SILENT project – WP5, a European Community co-financed project which aims to find sustainable and eco-compatible solutions to reduce noise in complex urban situations, where different noise sources are present (especially roads and railways) in densely inhabited areas. The described activities are related to the project phase of developed solutions and to the following implementation in the test site which has been identified between the city of Rome and its international airport: a major highway and a primary railway are located very close to each other, and a hospital is just between them. The solutions which are been chosen are "at source" mitigation: a noise-reducing asphalt for the highway and a Low Height Noise Barrier (LHNB) for the railway. They will be further adapted to the specifics of the test site.
Nowadays, a noise measurement campaign has been completed, in order to identify the current sound levels at various receivers.

Keywords: *noise, railway, roads, mitigation.*

1. INTRODUCTION

According to the World Health Organization, 20% of the European population is exposed to noise levels above 65 dB(A) during the day [1]. Reducing noise levels is particularly complex in urban environments, where various noise sources coexist. In such contexts, noise mitigation generally excludes the use of solutions that could interfere with the urban context, such as traditional noise barriers, for many reasons, such as the proximity of receptors to the noise source, visual impact, etc.
To achieve these goals, the LIFE SILENT project [2][3] involves the development of innovative and sustainable noise-reducing pavements for road infrastructure and low-height noise barriers (LHNB) for railway infrastructure and testing in a test site, in order to provide transport infrastructure managers with information to support the dissemination of these technological solutions.

2. INNOVATIVE SOLUTIONS

Regarding noise-reducing pavements, during the LIFE SILENT project, the solution developed in the IASNAF [4] project will be optimized. It consists of a sustainable low-noise mixture enriched with functionalized cellulose fibers of plant origin, by replacing them with waste materials (packaging and textiles) to make the process more sustainable.
As for the low-height noise barrier (Fig. 1), it will be made with recycled materials appropriately shaped based on recent results in the field of metamaterials to achieve better sound-absorbing performance and greater durability. The proposed solution, thanks to its reduced height, will provide significant landscape integration, thus reducing the visual impact usually attributed to traditional noise barriers while maintaining acoustic effectiveness to be quantified based on boundary conditions.

Figure 1. Example of a low-height noise barrier (LHNB).

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3. TEST SITE

The solutions developed and tested in the laboratory will be implemented in a test site located in a densely populated area (Muratella, Rome, Italy), which includes both roads and railways at close distance (see Fig. 2).

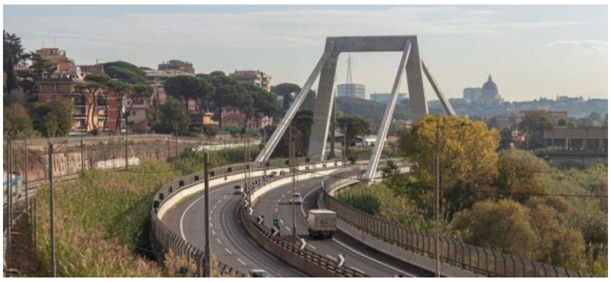

Figure 2. LIFE SILENT project test site.

Specifically, the identified area, which has about 150,000 inhabitants, is crossed by the Roma-Fiumicino airport railway line managed by RFI and the A91 highway managed by ANAS. The railway line is characterized by passenger traffic of over 70,000 trains/year with a maximum speed of 110 km/h, while the A91 highway is characterized by traffic flow of about 72,000 vehicles/day.
The pilot area mainly consists of residential buildings with 3-4 floors above ground at a short distance from the railway and highway. Additionally, there is the San Giovanni Battista hospital (see Fig. 3), located between the A91 highway and railway line.

Figure 3. San Giovanni Battista Hospital (aerial view).

According to the European Environmental Noise Directive 2002/49/EC (END), both infrastructures in the area must be acoustically mapped every five years and an Action Plan must be drawn up to define strategies and solutions to mitigate noise levels at receptors. The RFI Noise Remediation Plan (updated 2018), which also incorporates Action Plans, currently provides for two noise barriers in the investigation area measuring 385 and 704 meters long and 4 and 5 meters high along the railway line.
The mitigation measures provided by ANAS's Action Plan include noise-reducing pavement for an extension of 1.9 km and direct interventions at receptors. Additionally, there is already a 3-meter high noise barrier along the highway on the north side.

4. IMPLEMENTATION OF DEVELOPED SOLUTIONS

Prior to implementing developed solutions in the identified pilot site, some ex-ante evaluations will be carried out to set reference values against which to evaluate overall performance of new pavement and noise attenuation introduced by LHNB.
Specifically:

- Acoustic measurements of road pavements using Statistical Pass-by (SPB) [5] and Close Proximity (CPX) [6] techniques based on ISO 11819 standard to evaluate influence of existing pavement on traffic noise and calibrate source model. This evaluation will be carried out using Urban Pass-By Method developed within LIFE NEREiDE [7] project;
- Noise level measurements at receptors according to DM 16/03/1998 to calibrate propagation model;
- Texture and mechanical impedance measurements of road surface according to UNI CEN 13036-1 [8] and UNI EN ISO 7626-5 [9];
- Annoyance measurements of exposed population according to guidelines developed within LIFE NEREiDE project through psychoacoustic and social surveys. Zwicker descriptors defined by ISO 532-1 [10] and DIN 45692 [11] will be evaluated to determine psychological and physiological response of exposed population in terms of annoyance.

Based on inputs from measurement campaign, acoustic model will be calibrated and various scenarios simulated to map overall noise level and contributions from individual noise sources.
To facilitate monitoring of road section and make results robust and reliable over long term, pilot area has been equipped with DYNAMAP system [12], an automatic system capable of continuously measuring noise levels

and providing real-time acoustic maps developed within LIFE Dynamap project.
The sensor has been installed on a vertical road sign pole close to the A91 motorway and in proximity to the San Giovanni Battista Hospital (see Fig. 4).

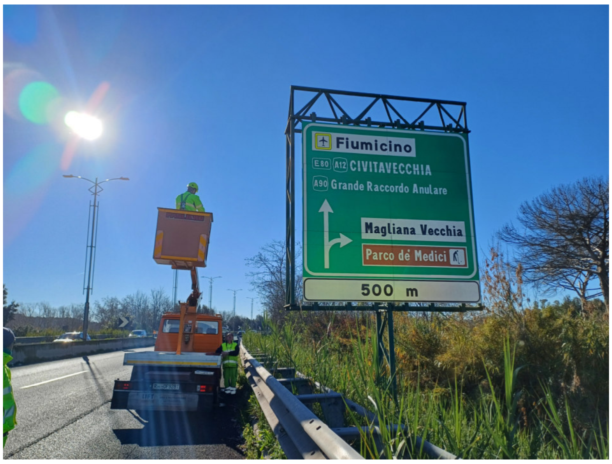

Figure 4. Dynamap sensor installation.

Then follows a design phase supervised by road and railway infrastructure managers to ensure appropriate safety standards during which developed solutions will be adapted to specific test site requirements. A co-design approach will also be promoted to ensure citizen participation in development of these solutions for easier acceptance.

Finally, noise-reducing pavement will be laid along a highway section measuring 1.9 km and low-height noise barrier (LHNB) will be installed along a railway section measuring 200 m.

5. CONCLUSIONS

Preliminary activities are currently underway for developing identified innovative solutions and planning field activities for LIFE SILENT project.

5.1 Measurements of road pavements

Measurements using the Statistical Pass-By Method were carried out in January and February 2025, in a site close to the San Giovanni Battista Hospital near a Smart Pole of the Anas Smart Road project (see Fig. 5).
Measurements of the acoustic emission due to tyre/pavement interaction by means of Close-ProXimity (CPX) method, instead, were organized on 2-3 July 2024. The CPX measurements were carried out in the slow and fast lanes of both carriageways, eastbound towards Rome centre and westbound towards Fiumicino.

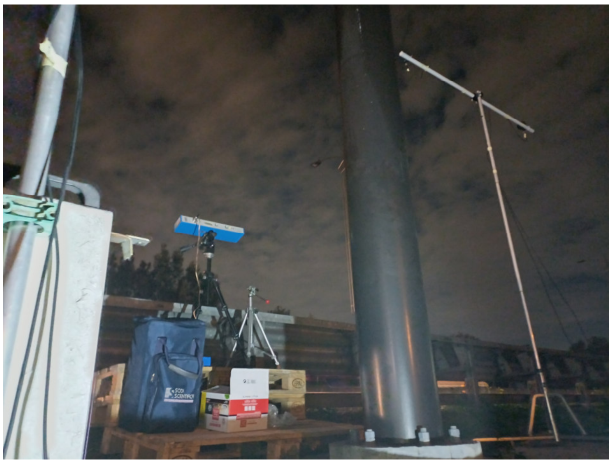

Figure 5. Statistical Pass-By set-up measurement.

For each road section investigated, at least three acquisition runs were carried out at the reference speed of 80 km/h.
On the road sections investigated there were different porous pavements, called in this report Ante Operam 1 (AO1), Ante Operam 2 (AO2) and Ante Operam 3 (AO3). Fig. 6 shows the instrumented vehicle used in the measurements.

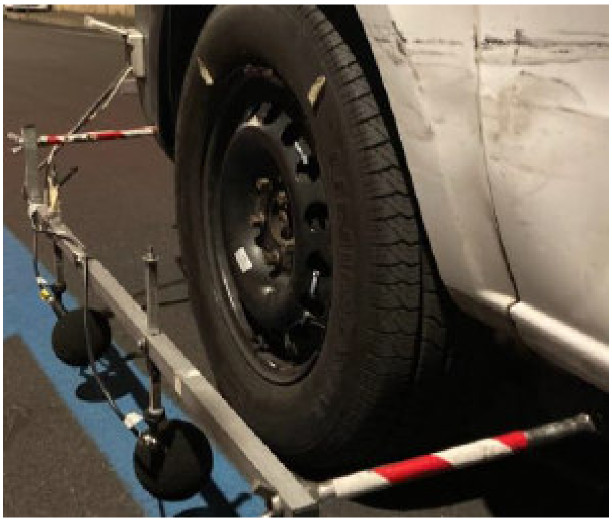

Figure 6. CPX instrumented vehicle

In Table 1 the results obtained for the road sections investigated are shown. The reported LCPX values represent the spatial average value over the section considered. For each of the investigated pavements, both the average LCPX level value for each run and the final average over all acquired runs are reported.

Table 1. Results obtained for the investigated pavements at the reference speed of 80 km/h.

Pavement	Lane	speed [km/h]	Run	East Direction		West direction	
				L_{CPX} for run [dB(A)]	L_{CPX} (Average) [dB(A)]	L_{CPX} for run [dB(A)]	L_{CPX} (Average) [dB(A)]
AO1	Slow	80	1	99.4	99.4 ± 1.0	99.6	99.8 ± 1.0
			2	99.1		99.8	
			3	99.8		100.0	
			4	99.4		96.0	
AO2	Slow	80	1	96.4	96.2 ± 1.2	96.1	96.0 ± 1.0
			2	95.5		96.0	
			3	96.3		101.5	
			4	96.5		101.6	
AO3	Slow	80	1	100.7	100.5 ± 1.1	101.4	101.5 ± 1.0
			2	100.6		97.8	
			3	100.7		98.1	
			4	99.9		98.1	
AO1	Fast	80	1	98.2	98.2 ± 1.0	95.7	98.0 ± 1.0
			2	98.2		95.6	
			3	98.2		95.7	
AO2	Fast	80	1	95.1	95.2 ± 1.0	102.3	95.7 ± 1.0
			2	95.3		102.1	
			3	95.1		102.2	
AO3	Fast	80	1	100.5	100.3 ± 1.0	99.6	102.2 ± 1.0
			2	100.1		99.8	
			3	100.3		100.0	

During data processing, the LCPX level was corrected for the reference air temperature and for the rubber hardness of the reference tyre as specified by the technical standards.
In addiction, at the same time, measurements of the road texture using a triangulation point profile sensor complaint with the requirements of ISO 13473 standards were carried out.
The texture measurements instead concerned only the slow lanes of both carriageways. Table 2 shows the results in terms of the MPD (Mean Profile Depth) indicator in the slow lane for the two directions analysed.

Table 2. Results obtained in terms of indicator MPD (Mean Profile Depth) for the investigated pavements.

Pavement	Direction	Lane	MPD
AO1	East	Slow	2.05 ± 0.32 mm
AO2	East	Slow	0.59 ± 0.10 mm
AO3	East	Slow	1.89 ± 0.17 mm
AO1	West	Slow	2.03 ± 0.22 mm
AO2	West	Slow	0.56 ± 0.09 mm
AO3	West	Slow	0.59 ± 0.12 mm

In a second stage, also texture and mechanical impedance measurements of road surface will be carried out to exploit the construction site built for the new pavement implementation.

5.2 Noise level measurements at receivers

Beside noise measurement at receptors to calibrate propagation model, a monitoring campaign has been organized in order to detect railway and road noise contribution.
The noise measurements were made according to the Decree of the Ministry of the Environment dated March 16, 1998, “Techniques for the detection and measurement of noise pollution.”
“PR” measurement locations (Reference Points) for the characterization of source noise were positioned, in free-field conditions, close to the railway and road line. “PS” measurement locations (Significant Points) were placed at the receivers, in particular at the most exposed façade to railway noise, at the middle position between the two sources railway and highway and at a receiver affected only by road noise.
In Fig. 7 a map extract with the indication of the measurement locations is shown.

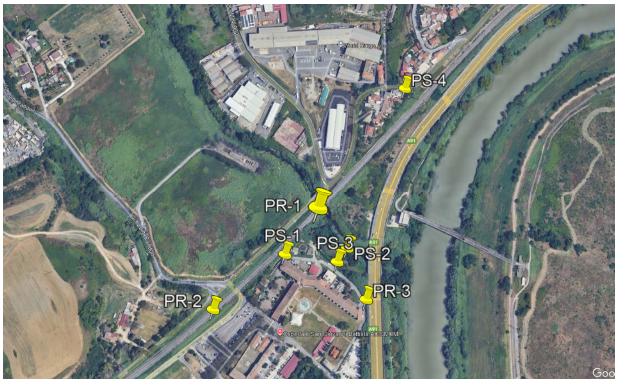

Figure 7. Measurement locations

Some pictures of the measurement campaign are shown in Fig. 8.
the results of the measurements are reported In Table 3.

Table 3. Noise measurements at reiceves results

Measurement Location	Leq,A [dBA] Day	Leq,A [dBA] Night
PR-1	63.2	55.4
PR-2	61.5	53.8
PR-3	61.4	57.3
PS-1	62.9	57.4
PS-2	58.9	55.0

PS-3	-	-
PS-4	65.2	61.8

at measurement location PS-3, individual train pass-bys could not be distinguished because of building ventilation and extraction system with predominant noise. Similarly, results at the measurement point PS-4 are affected by the presence of Via della Magliana close to the A91 motorway.

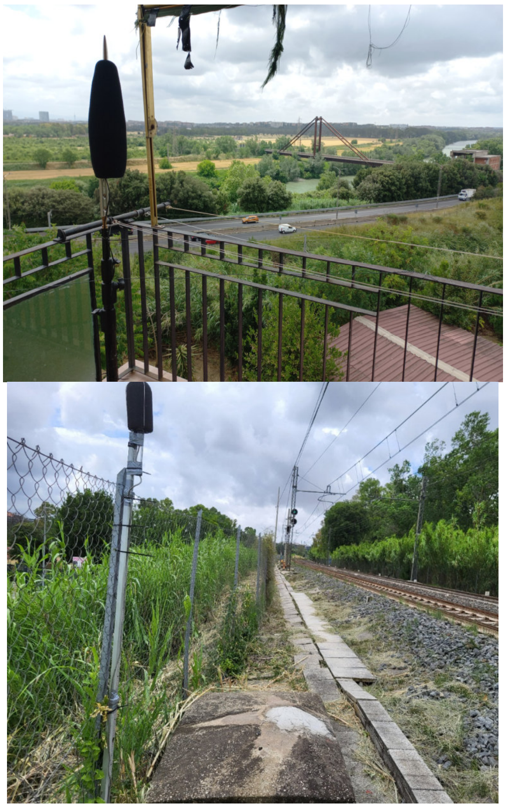

Figure 8. Measurements at receivers.

5.3 Annoyance measurements of exposed population

A questionnaire will be distributed and submitted to people present at a meeting with the president of the Municipality. Furthermore, on the same day it will be also distributed to families thanks to teachers of the school "I.C. Santa Beatrice - Plesso Santa Beatrice".

6. REFERENCES

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