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A PROCEDURE TO ESTIMATE RELIABLE MITIGATED SCENARIOS USING THE URBAN SPB

Elena Ascari[*1] **Mauro Cerchiai**[2] **Dulia Melluso**[3]
Luca Fredianelli[1] **Gaetano Licitra**[2]
[1] Institute of Chemical and Physical Processes - CNR, Via G. Moruzzi 1, 56124 Pisa, Italy
[2] Department of Earth Sciences, University of Pisa Via Santa Maria 53, 56126 Pisa, Italy
[3] Environmental Protection Agency of Tuscany Region, Via Vittorio Veneto 27, 56127 Pisa, Italy

ABSTRACT

The LIFE NEREiDE project developed monitoring guidelines for low-noise pavements (LNP). A method named Urban Pass-By (U-SPB) was developed in order to increase the applicability of standard evaluation procedures of the noise emitted by LNP. U-SPB originates from standard SPB, exploits unattended measurements and develops an in- lab pass-bys identification. The in-lab analysis allows obtaining a modelled noise level which is due only to road traffic noise passing by the selected road. U-SPB provides a model at the measurement point but standard noise models as CNOSSOS are commonly used to evaluate exposure and mitigation efficiency. However, not all kinds of LNP are represented in modelling methods, and it is hard to choose the right one in software. The present paper reports the application of U-SPB to urban cases with the aim of evaluation how much U-SPB can provide reliable models of scenarios mitigated with LNP. The resulting U-SPB modelled noise levels are compared with the noise mapping model before and after the laying of the LNP. This allows the proper surfaces' choice in software according to the real scenario but based on customizable traffic flows.

Keywords: *road traffic noise, low noise pavement, CNOSSOS-EU.*

[*]***Corresponding author****: elena.ascari@cnr.it*
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1. INTRODUCTION

The LIFE NEREiDE project implemented different LNPs to evaluate their efficiency in terms of Life Cycle Assessment [1]. Additional indicators were developed to better qualify efficiency on site: the U-SPB [2] is able to estimate the road specific contribution based on local fleet data. As the Controlled Pass By method [3] the U-SPB is based on local fleet peculiarities but avoiding attending measurements. A fixed monitoring station is placed roadside at 4 m height to gather U-SPB data [2]. Based on measured traffic flows it is possible to build a modelled noise level ($L_{DEN\text{-}USPB}$, $L_{Night\text{-}USPB}$) due to the single measured road. Such level is representative of the road contribution more than the roadside measured level, which instead take into account also other sources as other transport sources but also anthropogenic and animal noises, almost difficult to be properly eliminated.
Thus, this work compares $L_{DEN\text{-}USPB}$ and $L_{Night\text{-}USPB}$ with CNOSSOS output computed with a commercial software for *ante* and *post operam* scenarios (AO and PO in the following will then refers to original scenario and mitigated scenario respectively). Two different new surfaces, about 400 m long, layed during NEREiDE project are here considered: a gap wet LNP with End of Life Tyres (ELTs) and an open reference new surface [4]. Noise measurements were performed in a single point representative of each site and USPB levels derived at measurement. The section 2 describes the AO scenario and describes the selection of CNOSSOS surface which better fits to AO surfaces (old ones). The calibration is done modeling measured traffic flows over a whole week of measurement. The section shows the need of defining a specific tuned surface, i.e. a new type of surface not in the existing database, created in order to reproduce the frequency emission spectrum of the

real surface. Then, in section 3, the same surface selection is performed for PO scenario. All the available low noise pavement in CNOSSOS model [5] are tested against USPB derived values, taking advantages of PO traffic flows. Also for PO, an optimized surface is obtained to better fit measurement results.
Finally, in section 4 the efficiency of the LNP and the open reference pavement is established by comparing the software simulations obtained with optimized surfaces, assigning the same traffic flow. For the sake of simplicity, AO flows are used but relevance would be increased by using long term traffic flow provided by road owners or local/national databases. In fact, efficiency depends on flows since it is not the same for all the vehicles' categories [6].

2. ANTE OPERAM SCENARIO

The considered sites are in a smooth hilly municipality (Massarosa) along the regional road SR 439. The scenario is built in mapping software including Buildings, digital terrain model and all the needed elements. The AO measured traffic flow is included in road CNOSSOS model [5] and different surfaces were tested. Table 1 and 2 summarizes results for different surfaces in the two sites coded in the project respectively as M1, where open reference will be places, and M3, where the LNP gap wet will be layed.

Table 1. CNOSSOS modelled L_{DEN} and L_{Night} comparison to $L_{DEN-USPB}$ and $L_{Night-USPB}$ in M1 for AO surfaces and flows.

	L_{DEN} [dB(A)]	L_{Night} [dB(A)]
USPB	**67.2**	**58.5**
Reference Surface	65.9	57.5
Worked Surface	67.5	59.1
Optimized M1 AO	67.3	58.9

Table 2. CNOSSOS modelled L_{DEN} and L_{Night} comparison to $L_{DEN-USPB}$ and $L_{Night-USPB}$ in M3 for AO surfaces and flows.

	L_{DEN} [dB(A)]	L_{Night} [dB(A)]
USPB	**69.3**	**61.3**
Reference Surface	68.1	60.1
Worked Surface	70.0	62.1
Optimized M3 AO	69.3	61.4

Since old surfaces were modelled, reference type and worked type were tested. Then, the optimized surface was obtained by changing spectral parameters of surface characteristics (introducing a new surface typology with correction parameters α and β in the software) and minimizing modelled difference to U-SPB levels. The detailed explanation of the minimization technique would need a separate work, which is under development.
The optimized surface was tuned to USPB values and it provided values in between the two standard surfaces. In fact, the sites are old pavements in average conditions, whose renewal is set due to noise exposure requirements.

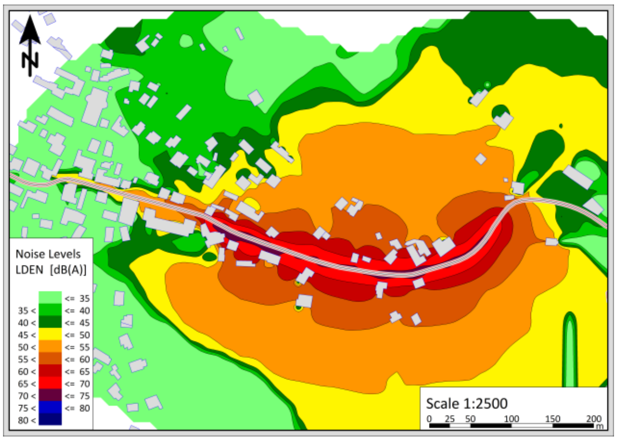

Figure 1. AO levels (L_{DEN}) in the M1 site according to modelled optimized surface.

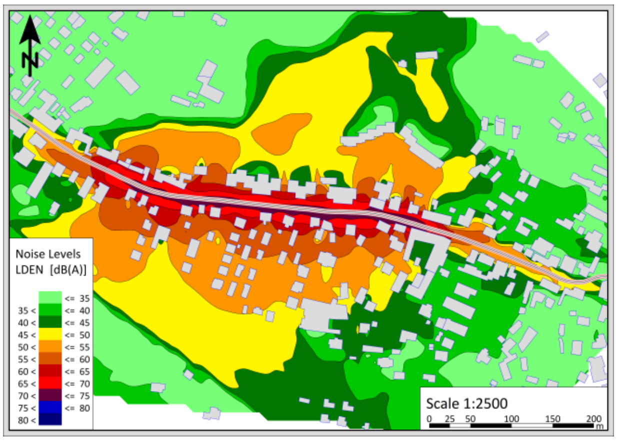

Figure 2. AO levels (L_{DEN}) in the M3 site according to modelled optimized surface.

Figure 1 and 2 show the noise levels in the M1 and M3 sites before realizing the mitigations according to measured traffic flows and optimized surfaces. The source was modelled only in the 400 m that were then renewed to avoid influence of adjacent stretches of road in evaluating AO/PO effects. All maps in this work were computed 4 m height above the ground.

3. POST OPERAM SCENARIO

The PO mitigated scenario was calculated by the software in the same areas and taking advantages of PO measured traffic flows. Since low noise surfaces are to be tested, a first selection of available surfaces (coherent with speed range and materials used), with emission lower than reference, was performed. Then these types were compared together with an optimized one.
Table 3 and 4 summarizes results in M1 and M3 in PO condition compared to the USPB modelled levels.

Table 3. CNOSSOS modelled L_{DEN} and L_{Night} comparison to $L_{DEN-USPB}$ and $L_{Night-USPB}$ in M1 for PO surfaces and flows.

	L_{DEN} [dB(A)]	L_{Night} [dB(A)]
USPB	**64.2**	**56.3**
REF	65.3	57.3
1 layer ZOAB	64.2	56.2
2 layer ZOAB	61.7	53.7
SMA NL5	64.2	56.1
SMA NL8	64.8	56.7
Thin layer A	63.1	54.9
Thin layer B	62.4	54.1
Optimized M1 PO	64.2	56.2

Table 4. CNOSSOS modelled L_{DEN} and L_{Night} comparison to $L_{DEN-USPB}$ and $L_{Night-USPB}$ in M3 for PO surfaces and flows.

	L_{DEN} [dB(A)]	L_{Night} [dB(A)]
USPB	**62.2**	**54.1**
REF	69.6	61.7
1 layer ZOAB	68.6	60.7
2 layer ZOAB	66.2	58.3
SMA NL5	68.6	60.5
SMA NL8	69.2	61.2
Thin layer A	67.5	59.5
Thin layer B	66.9	58.7
Optimized M3 PO	62.2	54.0

In M1 a standard open surface was implemented. Table 3 shows that more than a surface can obtain suitable results. Namely, the 1 layer ZOAB, the SMA NL5 and the optimized one seem similar but frequency is optimized in the last one.
In M3 an experimental gap wet surface was implemented and none of the standard surfaces is able to reach the values estimated by USPB measurement method. Thus, the optimized surface is the only solution to represent the implemented mitigation and to evaluate efficiency.

4. LNP EFFICENCY ESTIMATE

The aim of this section is to provide a reliable mapped efficiency of the realized mitigation. Thus, the optimized surfaces for each site and conditions (AO and PO) are used to calculate noise maps in the areas. To compare the two conditions in a correct way the same traffic flows were applied. In this work, AO flows were considered, but long-term average values should be used when available.
In table 5 and 6 the efficacy for each site in the measurement reference point is evaluated as difference between the surfaces optimized AO and PO.

Table 5. CNOSSOS optimized modelled L_{DEN} and L_{Night} comparison in M1 with AO flows.

	L_{DEN} [dB(A)]	L_{Night} [dB(A)]
Optimized M1 AO	67.3	58.9
Optimized M1 PO	64.6	56.1
Efficiency	**2.7**	**2.8**

Table 6. CNOSSOS optimized modelled L_{DEN} and L_{Night} comparison in M3 with AO flows.

	L_{DEN} [dB(A)]	L_{Night} [dB(A)]
Optimized M1 AO	69.6	61.7
Optimized M1 PO	60.5	52.2
Efficiency	**9.1**	**9.5**

Figure 3 and 4 show the difference map between AO and PO conditions in M1 and M3 as modelled according to the optimized surfaces.
As foreseen, in M1 the new surface obtains an efficiency which is comparable with a standard renewal of the surface.

Values are 2.7 in free field conditions and decrease behind obstacles.
The LNP implemented in M3 has a great efficiency at the measurement reference point, more than 9 dB(A), meaning equivalent to having reduced the traffic to 12% of the original one.

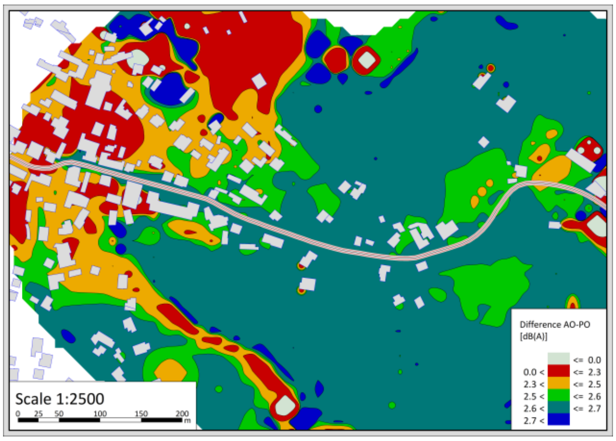

Figure 3. Efficacy map: Difference between AO and PO conditions modelled with optimized surfaces in M1 (old surface vs open reference new surface).

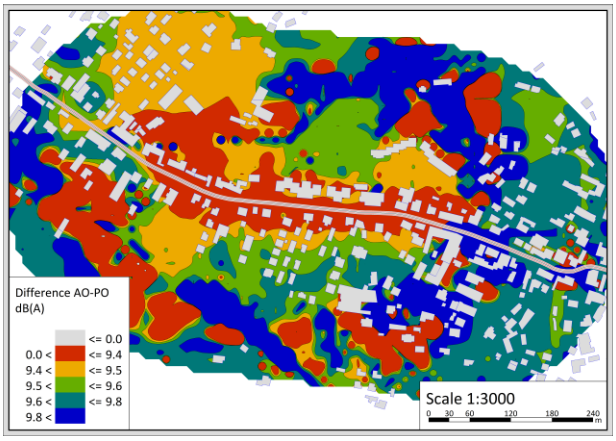

Figure 4. Efficacy map: Difference between AO and PO conditions modelled with optimized surfaces in M3 (old surface vs gap wet LNP).

5. CONCLUSIONS

The work establish reliable surfaces for modelling noise in case of a LNP is in use. The surfaces are tuned comparing the modelled noise to USPB values which correspond to real noisiness of the single road. This would be much more reliable than to tune on simple measurements. Then the efficacy of the mitigation is evaluated comparing scenarios with optimized surfaces such that the efficiency of the mitigation can be established for the whole area in terms of referen0ce flow. Since the surfaces are optimized on frequency content, even the propagation of the effects of the mitigation is much more reliable. Further studies should support this assumption with ad hoc measurements.

6. REFERENCES

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