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Measurements on Real Urban Traffic Noise Demand Higher Accuracy on Local Data to Get a Representative Application of Cnossos-EU

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ABSTRACT
Noise emission at low speed is acquiring a higher relevance to get representative results in urban noise mapping. The results of pass-by noise measurements on real urban road traffic in several streets offer a reference to assess the accuracy on strategic noise maps. Results of measurements carried on at different streets of three cities, mainly on light vehicles, show clearly how noise levels decrease when speed diminishes from 50 to 20 km/h, confirming how effective are policies that reduce speed limit in cities to attenuate noise in urban areas. Besides they also offer a reference on the dispersion data in real traffic measurements and a comparison with noise emission of different calculation methods. Conclusions advert that Cnossos-EU have the risk, at least in the test area, of underestimating emissions respect to real noise levels if the different variables established in the method to describe the sound power levels, are not well adjusted to the local values. To get realistic results for urban traffic noise, it will be required a more detailed local emission characterization and better input data as pavement type, age and maintenance conditions. Solving that, Cnossos-EU will contribute to improve the accuracy on urban noise maps.

Keywords: Noise, Road traffic, Cnossos
I-INCE Classification of Subject Number: 13, 76

1. INTRODUCTION

Traffic noise is the main contribution to the urban noise and, consequently it is the main objective to the city noise action plan in order to reduce the population exposed to noise over the objective values established for this pollution and to reduce the effects of noise on population health.

Traffic management under sustainable policies are focused in reducing traffic, promoting the use of public transport and the non-motorized displacements together with speed reduction on most of the urban streets. These policies requires that urban traffic noise assessment methodologies will be able to reflect the effect of these city actions on urban noise, considering all the relevant variables that have incidence on the noise levels.

Methods and model applications must progress in order to increase its accuracy and obtain high enough precision degree on noise levels due to different vehicles categories and elements having incidence on the emission, to allow to faithfully represent

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the real situation of urban traffic noise. This is more relevant in urban noise, where speed, driving conditions and elements to control traffics speed, have a different role than in roads. To reach this aim requires that noise emission methods and how the model setup is prepared to reproduce the real world, reflect the effect of the main variables contributing to noise emission

Since EU Directive 2002/49/CE, the European reference to road traffic noise was the NMPB-96 method, which generally overestimates noise emission, especially at low speeds, not being able to give realistic values to assess the noise emission for speeds around 50 Km/h and under. The new Directive on 2015, with the European common methods: Cnossos-EU, gives a new references that introduces a more detailed description of noise emission, being able to describe most of the main effects contributing to noise emission of urban traffic noise.

However traffic noise described in Cnossos should be considered as a reference proposal, since local characteristics of vehicles, driving conditions, pavements, etc. could have a significant incidence on the emission values, existing a significant deviation from the general method. Therefore in order to get a sufficient accuracy, the user should introduce all the local effects in the different variables of the method.

Our company, AAC, started collecting information about noise emission values in cities where we are working on their noise maps or action plans, in order to have local references from measurements taken on streets where real traffic represents the general city conditions. The aim was to support with local data the criteria applied to calculate the city noise maps when 30 km/h limit is introduced in determined areas of the city. This policy that is considered as a noise reduction action is not reflected by the official method, NMPB-96, requiring the definition of alternative criteria in the urban noise evaluation. Being one of the main solution to reduce the traffic noise in the cities, it was key to have a minimum support with local measurements.

Measurements provided some few references to assess the applied criteria in the last noise map in 2017 and they also gave a first reference to estimate the future possibilities in this matter to the action plan.

Combining these individual data from each city, the whole sample of emission data is sufficient to represent the noise emission in cities with similar characteristics for their urban traffic. All the measurements were made applying the same methodology and looking for comparable measurements points, and hence the results are also useful for a first evaluation about how Cnossos represents the noise emission of urban traffic noise in real situations.

Besides, the introduction of the new method offers a better characterization of the urban traffic noise emission and, hence, it is important to know how to adjust and apply this method defining the different variables available to represent the area of study in the best manner to increase the accuracy in specific cities.

AAC has made measurements with real traffic in streets of the three main cities of the Basque Country, in the North of Spain: Bilbao, Donostia–San Sebastian and Vitoria-Gasteiz.

Being conscious that it is quite difficult to get a good accuracy on noise emission measurements, especially when the measurements are using real traffic on streets that are trying to represent the general conditions in the city. Nevertheless we defined a practical methodology to get enough representatively for the study purpose. The selection of the measurements points share similar conditions to get comparable results in all the measurements, but assuming difficulties to get it and being necessary sometimes to accept small deviations from ideal measurements emplacements.

The methodology applied in the measurements give a reasonable good approximation to assess how representative the different calculation methods to describe local noise emission in the analysed cities are and to identify the main variables to increase accuracy including local effects. They offer a first reference to evaluate how to get a close approximation to the real emission in a specific city, region or country.

2. METHODOLOGY

Noise emission values have been defined as sound exposure level, L_{AE}, at 7.5 m of vehicle axis. The Measurements have been made on different streets mainly on flat streets, with good or usual pavement conditions and with traffic conditions that make possible to measure just an individual car each time, measuring L_{AE} and speed. The selection was made looking for streets sections where it is expected that cars drive at constant speed. When necessary distance effect or reflections effects have been corrected. All the measurements are on streets with conventional asphalt, which is the most usual in the analysed cities.

Each measurement point has been independently analysed to check that reasonable results are obtained, before making a global analysis for each city.

Just two points were selected to check the effect of low and medium slope in the emission values against conventional streets. The remaining measurement points try to cover a representative sample of the general pavement conditions in the streets: age or maintenance, while fulfilling the above mentioned conditions to get comparable results in order to have a first reference about the general situation in each city.

The data base created with these measurements covers 14 measurements points in the three cities, where traffic conditions, asphalt type and other variables reasonably could be considered as representative for most of the city’s streets.

The main objective for the measurements were to have references to increase the accuracy of the calculation of noise emission at low speeds, in order to get more representative results in the noise maps and a better definition of the effect that the reduction of traffic speed from 50 Km/h to 30 Km/h or 20 Km/h has on noise levels, to be able to assess how this growing policy in the cities impacts on urban noise, being adequately reflected on the evolution of the noise maps and on the indicators about the population exposed to environmental noise.

3. MEASUREMENT RESULTS AND NOISE EMISSION METHODS

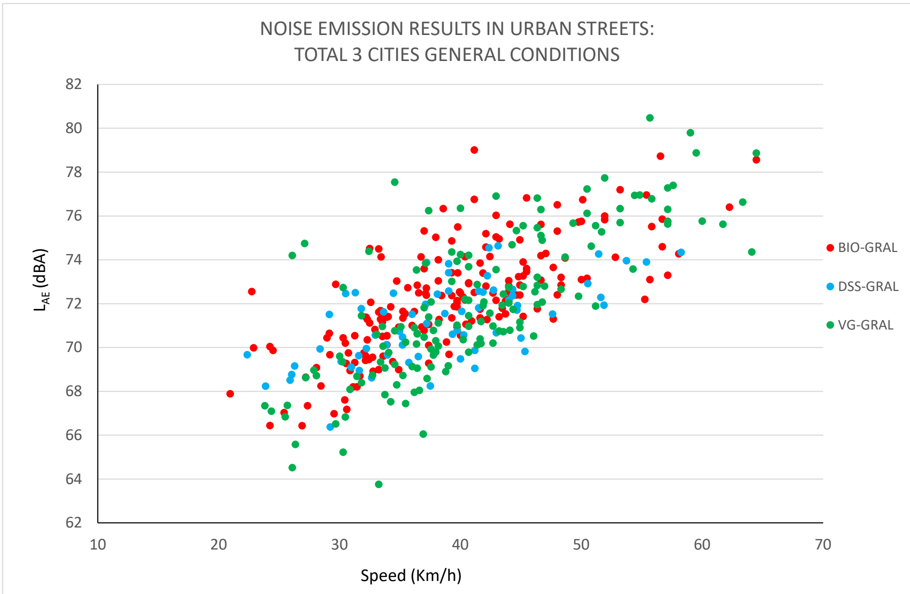
The results show clearly that noise emission reduces when the speed reduces, thus it is necessary to have an accurate reference to evaluate the effects of speed limit in urban streets, as a main action to control the urban noise.

They also show a significant dispersion in measured values, as it could be expected because the measurement accuracy together with the use of real traffic that induce a sample with different: car types, maintenance conditions and other factors. To reduce these deviations requires a higher amount of samples to get more representative results and try to improve the accuracy in the measurements, but a relative high dispersion must be assumed in real traffic. Nevertheless the collected samples could be useful to establish a first approach to the requirements to increase local accuracy on urban traffic noise.

Graphics below show the obtained results in each city, showing a similar tendency and range of values in the three cities.

Results at each measurement point in the three cities

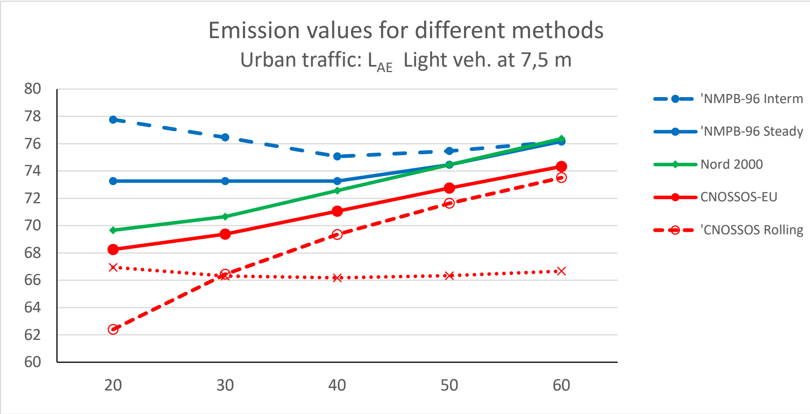
Adding all the results, but removing one street with relative high slope (around 7 %) we could have a representative sample of the average traffic conditions in the cities. These results confirm a clear relationship between sound emission and low speed that justify the positive effect for policies which reduce the maximum speed limits in the cities.



Results on typical streets conditions in the three cities

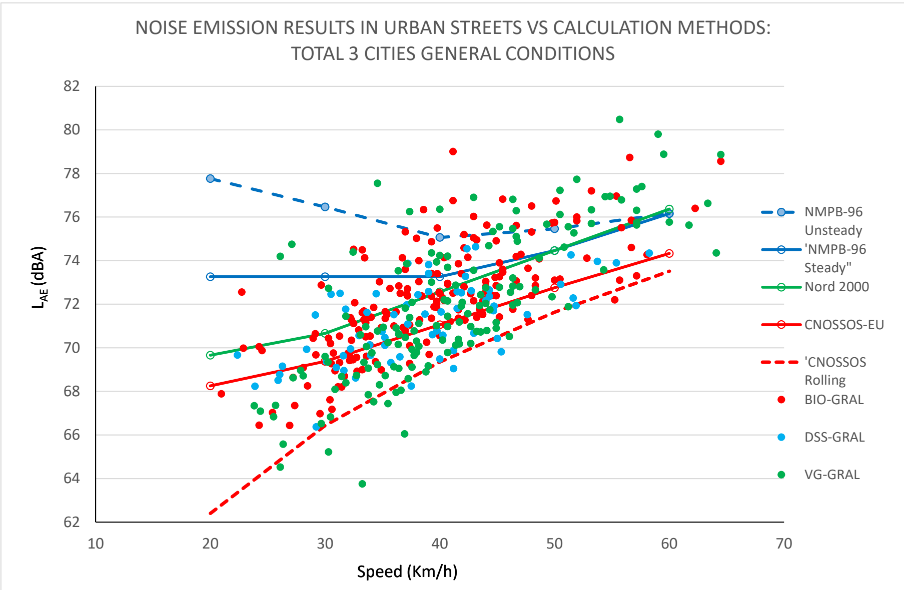
Regarding how the calculation methods reflect the noise levels in these cities, the obtained results during the measurements in the three cities, for general conditions, are compared with the noise emission levels for different calculation methods at urban traffic speeds. The comparison includes the EU official methods for road traffic noise (EU Directive 2002/49/CE: method NMPB-96, and EU Directive 2015/996: method Cnossos-EU) and the method Nord 2000.

The next graphic compares these methods for L_{AE} values at 7.5 m, including also the emission for NMPB-96 unsteady traffic conditions, typical for urban traffic, and the two components for Cnossos: rolling and propulsion noise. All the methods are considering the pavement reference of the method, without any correction for pavement or other variable.



Noise emission values as L_{AE} at 7.5 m for some prediction methods

Comparing these values with the measurements results under the same general conditions in the streets, it is possible to have a first reference about how the methods are representing the values measured in real traffic.



Measurements results for typical conditions compared with emission methods

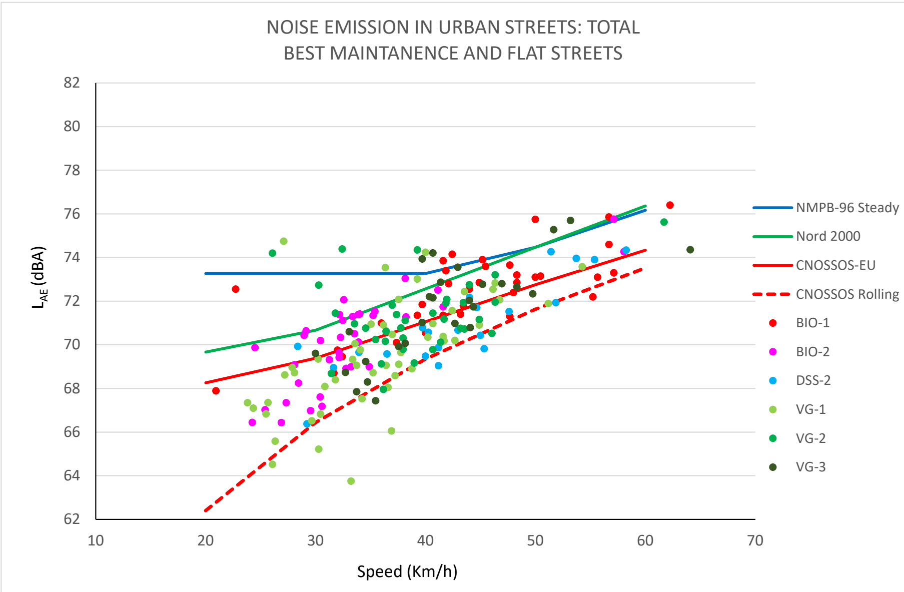
The comparison confirms that NMPB-96 is quite far from noise emission values at low speed and the analysis with the methods gives different results along the speed range.

- For 20-30 Km/h Cnossos fits reasonable with the measurement, and even most of the measurements values are under the method.
- For 30 Km/h to about 45 Km/h, Cnossos represents an average value of the measurements.
- Over 45 Km/h most of the measurements shows values over Cnossos, being closer to those from Nord2000 and NMPB-96 method.

These results point to a higher increase of the emission with speed that Cnossos predicts, and they support that probably additional variables of Cnossos must be considered to get a better adjustment to real situations.

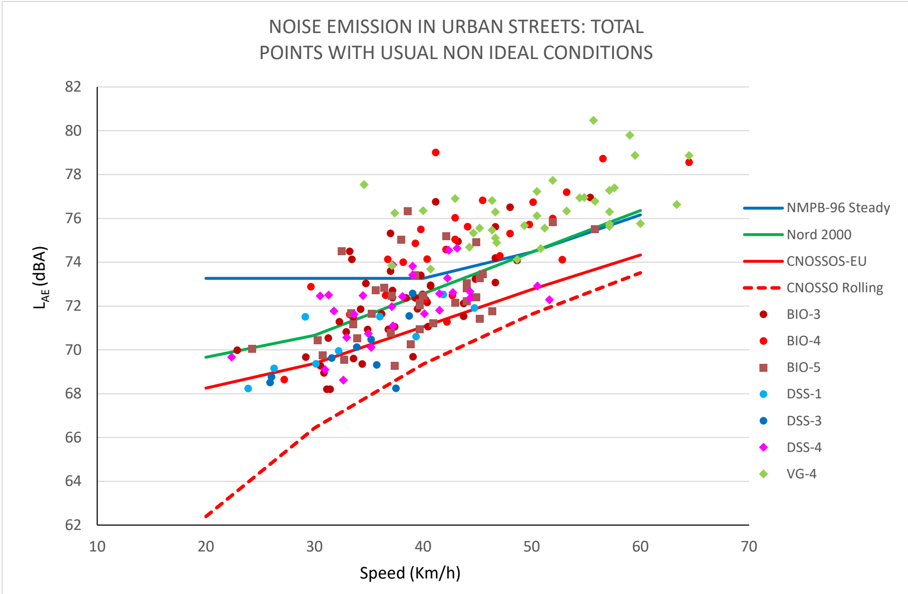
To analyse this possibility, a second test is made removing from the global sample those measurements points where, even being representative of the city streets, could have characteristics that couldn't fit with the reference condition assumed in the methods. A reduced sample is made considering only the measurements points in the three cities with the best conditions: very good pavement, completely flat and low incidence of other effects in the results, in order to compare these ideal situations with the methods.

The results in the graphic below, show that Cnossos now fits better with the measurement results, especially in the range from 30 to 50 Km/h. Between 20 and 30 Km/h the measurements value are under Cnossos and over 50 Km/h, it seems that Cnossos underestimate, but with limited samples in both sides of the speed range. In these ideal conditions, Cnossos fits better than Nord 2000 that generally gives values over the measurements results.



Measurements results for the best street conditions compared with emission methods

Looking to the removed data, it is possible to see that emission values grow, mainly at speeds over 30 Km/h, showing that when other usual conditions in the urban streets, as older pavement with higher texture and less uniformity, are presented, some type of correction must be considered in Cnossos. It is important to say that these data refers to the surface conditions that could be considered as a not bad pavement and they are quite usual in many streets.



Measurements results for other usual street conditions compared with emission methods

These results shows that Cnossos represent quite well noise emission if the pavement street is quite new, with really good conditions and in flat situations with steady speed. But many of the streets in the cities are not in these ideal conditions, and then noise levels are higher. If an adequate correction isn't included in the emission parameters, a relevant underestimation of the noise levels in the city are expected. Consequently pavement references for local conditions must be added to the Cnossos pavement data in order to get enough accuracy to get representative results of the real conditions in the cities, avoiding artificial noise reduction forgetting the substantial effect of the real streets of the city.

Of course, the rest of corrections included in Cnossos must be also considered to get valid results as road gradient, acceleration and deceleration effect etc. Concluding that, as it was needed, a more detailed model of the cities is demanded by Cnossos than it was by NMPB-96.

4. CONCLUSIONS

A direct application of the Cnossos-EU method to the urban road traffic, without considering corrections to characterize local conditions, could produce non representative results of the real situation and, probably, an underestimation of the noise levels, that will results into an unrealistic reduction of the indicators about exposed population to noise, due to an artificial dismissing of the noise problems.

The application of Cnossos must consider the effects of the different variables described in the method, being really relevant in urban areas the pavement type, where also local references for corrections due to age or maintenance level or similar should be included, to adjust the method to local emission values.

The change from NMPB96 to Cnossos-EU as official method, must generate a relevant reduction in noise levels, mainly in streets with low speed, but it could produce an excessive high reduction of noise levels in cities if Cnossos is not correctly applied, using all the variables to define the emission and without adjusting the local characteristics of the cities.

The change to Cnossos is a good opportunity to increase accuracy in urban noise assessment, but it is also a risk since noise levels could be artificially reduced, discrediting the methods and the assessment methodology based on calculation methods.

Previous studies must be made in the cities to adapt Cnossos to real conditions and, if not, a security coefficient should be included in the assessments, to prevent the underestimation of the traffic noise levels in urban streets.

Lastly a more detailed method demands a more detailed and complete acoustics model to obtain city noise maps.

5. ACKNOWLEDGEMENTS

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6. REFERENCES

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