MADRID
inter.noise 2019
June 16 - 19
NOISE CONTROL FOR A BETTER ENVIRONMENT

Methodological proposal to minimize environmental noise generated by building works

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ABSTRACT

Building activities generate – in most cases – high noise levels. Taking the acoustic variable into account during the planning and execution of works is the most effective way to avoid disturbance in acoustic areas adjacent to the building site and also to avoid complaints from neighbours.
At Audiotec we have developed our own methodology, based on years of experience and on our knowledge of the building sector. In this methodology we propose that acoustic professionals work in coordination with planners, designers and project managers from the very beginning of the building planning process, in order to prevent noise.
For this kind of activity, the role of acoustic professionals must be active and comprehensive, not limited to estimating and reducing noise levels, but also involving participation in scheduling tasks, stocks and machinery management, and decision making during the design process. This position therefore requires specific expertise in architecture and construction areas.
In this paper, we present our methodological approach for limiting the acoustic impact generated at building sites. Its aim is to prevent environmental noise from being generated in the first place, rather than adopt subsequent corrective measures.

Keywords: Noise, Environment, Building activities,
I-INCE Classification of Subject Number: 50

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1. INTRODUCTION

In some territories, noise regulations include the need for carrying out an acoustic study on building activities in order to create a prior assessment of the acoustic impact they will have and take all necessary precautionary or corrective measures to reduce the expected noise levels.

This can be used both to make an acoustic study proposal for meeting regulatory goals and to highlight the importance of integrating the acoustic expert within the multidisciplinary team involved at all stages of the design, implementation and monitoring processes. Decision making mechanisms including acoustic variables are the best way to ensure that construction site noise and associated disturbances to residents are brought down to the lowest level.

This paper presents the methodological proposal developed by Audiotec for approaching this type of work. The proposal has been based on a real residential building construction site. The site is located in the vicinity of a residential area.

2. THE ROLE OF THE ACOUSTIC ENGINEER DURING THE BUILDING PROCESS

The whole construction process can be divided into the following stages:

- Preliminary stage, which includes the draft of the preliminary project, the project implementation and the health and safety plan.
- Project implementation.
- Legalisation and useful life.

The involvement of an acoustic engineering firm from the early stages of the project is highly recommendable. Audiotec's methodological proposal is based on the active involvement of an acoustic engineering team during the first two stages of the construction process.

The following proposals are suggested for the preliminary stage:

- Involvement in the preliminary project:
    - Comprehensive analysis of the acoustic impact of the future construction works, considering the site's position and the presence of noise-sensitive buildings nearby.
    - Analysis of applicable legislation regarding background noise and acoustic conditions.
    - Initial assessment of noise affection of the different proposed solutions.
- Involvement in the project implementation:
    - Preliminary analysis of the different building techniques to be employed and proposal – if applicable – for quieter alternatives.
    - List of machinery to be employed at each building stage.
    - Predictive acoustic studies in order to analyse the acoustic impact of each stage (once the technologies to be used in the implementation process have been defined and the initial plan has been drafted). As a result, alternative, lower acoustic impact technologies and a list of measures to lower environmental noise may be proposed.
    - Acoustic simulations for assessing the impact of the proposed alternatives, which must be carried out at the proper time.
- Involvement in the health and safety plan:
    - Drafting an environmental surveillance plan for background noise control for the entire duration of the construction process.
    - Collaborating in the choice of individual worker equipment including noise protection.

During the implementation stage, the following actions are suggested regarding the decision making process:

- Involvement in planning of works in order to optimise their sequence with the aim of reducing environmental noise levels and avoiding the overlap of acoustically intense tasks.
- Control of building processes and planned pre-emptive and corrective measures.
- Control and monitoring of the proposed environmental surveillance system.
- Involvement in daily management and supervision of on-site works.
- Participation in training and awareness raising activities for workers in order to reduce noise generation.

3. CASE STUDY: BUILDING SITE

We will present a real-life building site case in order to illustrate the methodological proposal developed by Audiotec for the management and control of environmental noise on building sites.

3.1. Building site neighbouring area

The first step consists of analysing the site's location and neighbouring area. The neighbouring acoustic areas are analysed, and the site's acoustic sensitivity and legal environmental noise threshold are determined.

In this case, the site is located near a residential area including inhabited residential blocks about 80 m away and is next to some lots that remain empty.

3.2. Main noise sources present before start of works

Before the beginning of the building activities, a list of acoustic emitters near the building site is drafted and their noise affection measured.

In this case study, the neighbouring streets are used for accessing the residential blocks. It is a low building density area and the traffic density and associated noise are also very low, always under 60 dBA. There is no large, noise-emitting transport infrastructure to be found in the area, such as railroads, nor are there industrial or airport/port activities. It is indeed a particularly quiet area from an acoustic viewpoint.

3.3. Machines and tools to be used during works

At this stage, a list of machinery to be used as well as an evaluation of the acoustic power generated by each machine and a classification of the noisier equipment is drafted, consistent with the building units to be implemented and the techniques to be employed.

For this particular case study, the machinery list is as follows:

Compressed-air machines and tools:

- Compressor power unit
- Compressed air tools: hammers, drills, thread formers, riveters, joggers, etc.

Electric machines and tools:

- Power unit
- Tools: hammers, cutting tools, other-purpose tools (polishers, joggers, mixers).

Pumping machines:

- Pressure units
- Pumps

Outdoor earth and materials moving machinery:

- Excavators

- Loaders
- Trucks
- Dumpers

Other machinery for mixing, transporting and unloading cement mortar and concrete:

- Truck mixer
- Concrete pumps

Lifting and handling tools:

- Cranes
- Cargo elevators
- Fork and platform lifts

The table below shows the acoustic power values for the machines that are heavily used for building activities. The information comes from equipment technical data and tests carried out by Audiotec:

MACHINE TYPE	ACOUSTIC POWER L_{aw} (dBA)
Excavator	101
Air backhoe	99
Breaker hammer	122
Dump truck	103
Dumper	90
Crane truck	103
Compressor	86
Power unit	109
Truck mixer	106
Impact wrench	135
Mitre saw	116

3.4. Main noise sources from works

Works in this case study have been implemented through 4 building units. For each unit, works have been analysed, machinery has been listed and a calendar has been established. At this stage, prior to drafting the building project, the acoustic consultant proposes technically and economically viable alternatives for the consideration of the planner in order to reduce noise pollution levels.

Unit 1: Earth movement and development:

Including land moving, embanking and foundations.

Operations are carried out using manual and mechanical tools. Main equipment to be used includes loaders, breaker hammers, compressors, vibrating shaker screens, land-moving vehicles and steel reinforcing and concreting equipment.

For this particular study case, the scheduled time for implementing tasks in this unit is approximately 120 days.

Unit 2: Structure building

Includes on-site implementation of steel structures and arcaded, reinforced concrete structures.

Main equipment to be used for this building unit includes cargo lifting and handling machinery (tower crane, truck crane) and machinery for making, moving and pouring cement mortar and concrete (truck mixer, concrete pumps, joggers, etc.).

This stage is expected to last for about 80 days.

Unit 3: Walls and windows

Terracotta brick inner walls, light-thermal-terracotta and concrete blocks; carpentry work (doors and windows), glasswork and roofing.

Usual tools for this type of activities. High acoustic impact of hammers, drills and angle grinders for brick cutting.

This unit will last 180 days.

Unit 4: Inner works

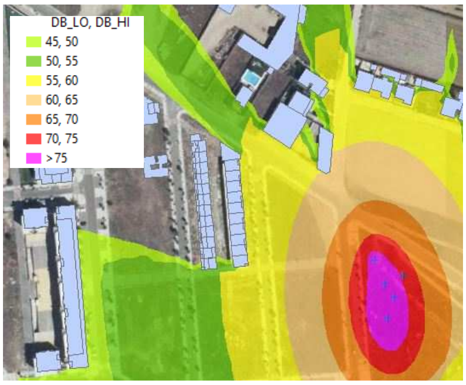
This unit includes refurbishment, facilities, facing, tiling, trimming, plastering and painting, as well as floor, staircase and ceiling facing and panelling.

3.5. Acoustic modelling of operational conditions

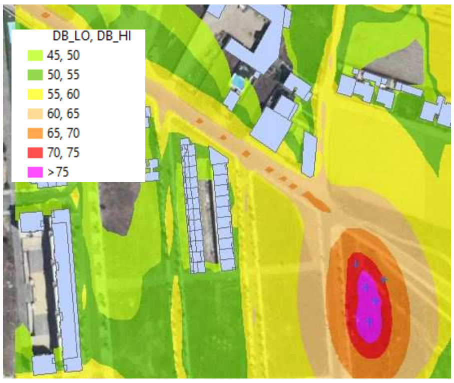
At this stage, an acoustic model is developed for each building unit in order to characterise inmission and environmental noise. Results will facilitate the assessment of compliance with legal noise thresholds.

Unit 1: Earth movement and development:

Inmission noise.



Environmental noise

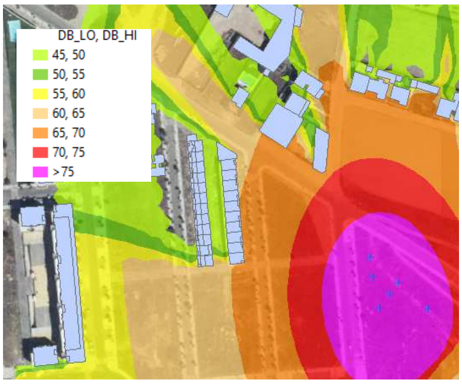


Sound level maps, 4 m above ground level.

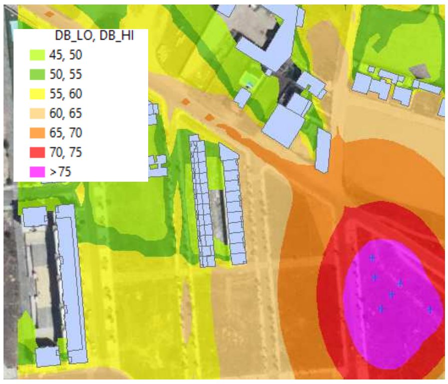
For this building unit, results show moderate sound inmission and environmental noise levels.

Unit 2: Structure building:

Inmission noise



Environmental noise

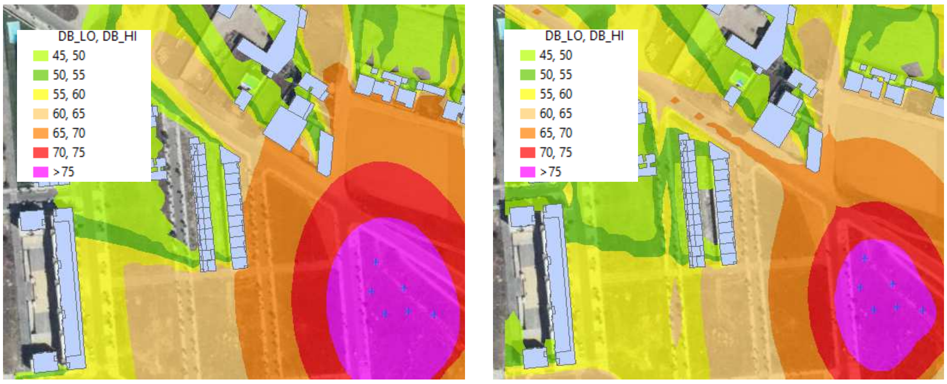


Sound level maps, 4 m above ground level.

In this building unit, higher noise levels than those of the preceding unit are expected. Noise levels affecting nearby buildings exceed limit values.

Unit 3: Walls and windows:

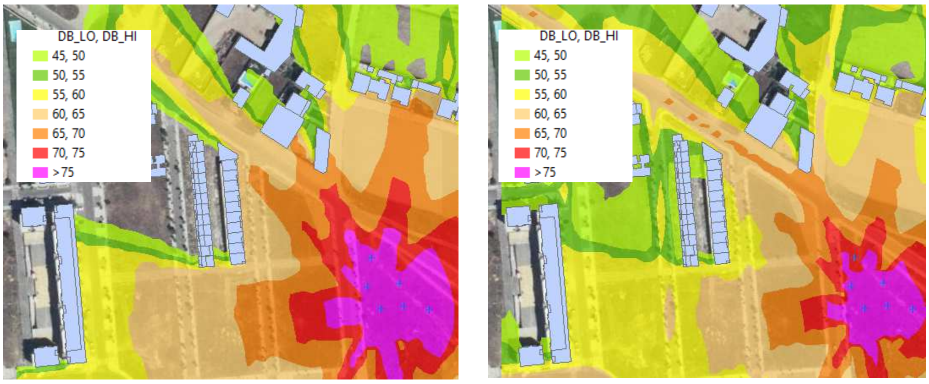
Inmission noise | Environmental noise



Sound level maps, 4 m above ground level.

Estimated noise levels for this unit are similar to those for the preceding one.
Unit 4: Inner works:

Inmission noise | Environmental noise



Sound level maps, 4 m above ground level.

In this unit, the walls will have a shielding effect. Sound will carry outside essentially through window and door openings.

3.6. Proposal for pre-emptive measures and acoustic analysis of improvement impact

Based on the information obtained during the previous stage, alternatives for the initial plan are proposed with the aim of reducing noise levels during the implementation of works. Some of these measures concern the drafting of the building project, while others are related to the general planning of on-site works and their daily implementation.

For this study case, measures are as follows:

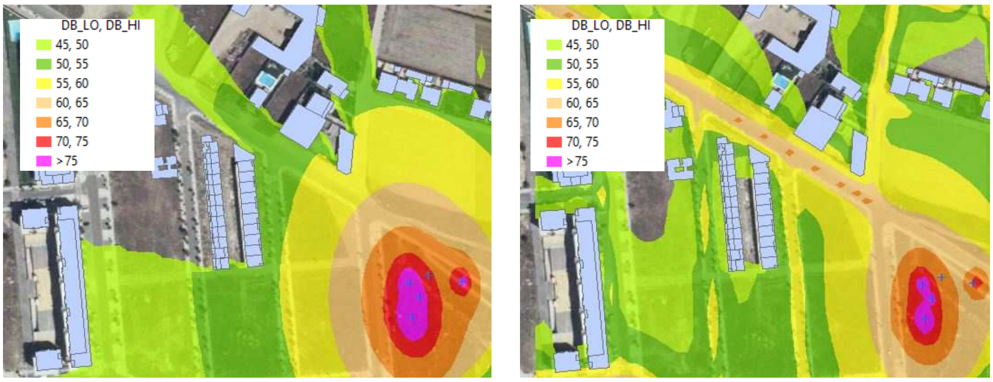
- Substituting noisy machinery at some stages for quieter equivalents.
- Using several techniques and resources in the different building units in order to minimise noise. For instance, using mortar prepared off-site.
- Relocating the mobile offices to a place where they may have a noise-shielding effect on nearby inhabited residential areas.
- Relocating the stocking area to a place that is further away from nearby residential areas and has a better access.
- Modifying the scheduling of works in order to avoid the overlap of noisy activities.
- Redefining the sequence of works so as to use walls as shields.

- Fostering the use of prefabricated elements instead of ones prepared on-site.

After the adoption of the proposed measures, a new acoustic simulation has been made in order to assess new noise levels. Results are as follows:

Unit 1: Earth movement and development:

Inmission noise | Environmental noise

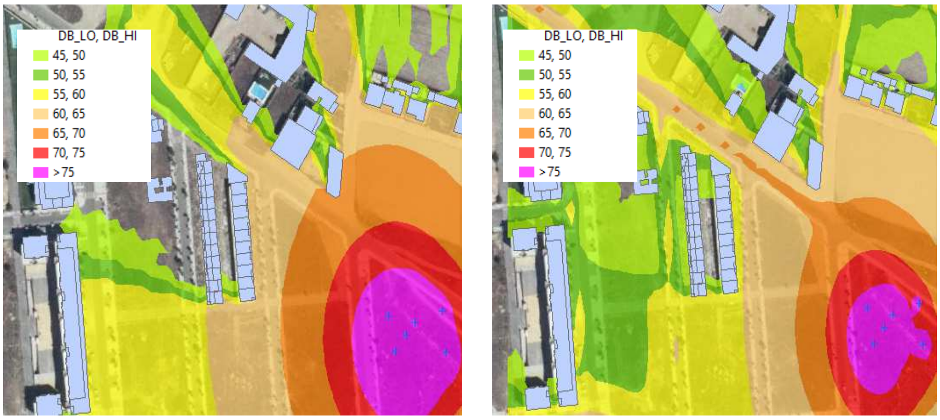


Sound level maps, 4 m above ground level.

For this building unit, there is a noise level reduction of 2 dBA.

Unit 2: Structure building:

Inmission noise | Environmental noise

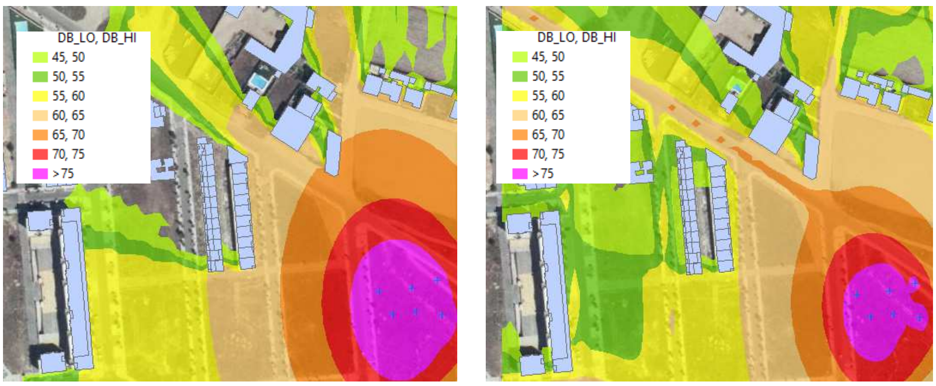


Sound level maps, 4 m above ground level.

For this building unit, the estimated noise levels are 3 dBA lower.

Unit 3: Walls and windows:

Inmission noise | Environmental noise

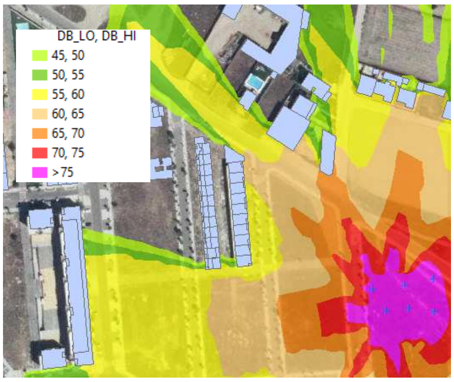


Sound level maps, 4 m above ground level.

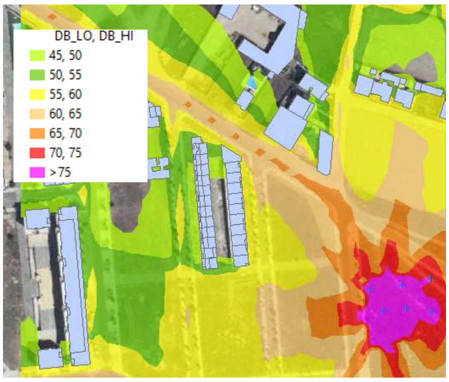
The newly estimated noise levels for this unit are 3 dBA lower than those initially estimated.

Unit 4: Inner works:

Inmission noise



Environmental noise



Sound level maps, 4 m above ground level.

The newly estimated noise levels for this unit are between 2 and 4 dBA lower than those initially estimated.

3.7. Other noise management and control measures to be taken

Besides the aforementioned measures whose effectiveness has been proven, some other more general measures can be taken as part of the case study, such as:

- Adopting the necessary measures to minimise the acoustic impact on workers and comply at all times with the workers' health and safety regulations regarding noise exposure. Therefore, all equipment or equipment areas which might exceed a 85 dBA noise level are to have warning signals and individual hearing protection devices are to be made available.
- Requiring an official type-approved data sheet – by an authorised technical department – of all machinery to be used during works, so that all construction machinery, equipment and motor vehicles meet the legal requirements regarding environmental sound emissions for outdoor machine operations.
- Establishing and following a protocol that will guarantee a proper use and maintenance of all machinery and tools used on-site, in order to keep noise levels as low as possible.
- Respecting the planned time schedules for on-site activities.
- Paying special attention when planning noisy activities and avoiding such activities in the early morning wherever possible; limiting materials reception times.

4. CONCLUSIONS

- This article is presented as a methodological proposal for the management and control of environmental noise generated by a construction site, with realistic measures affecting both the project definition stage and the implementation stage.
- Taking construction-site generated environmental noise into account from the project drafting stage is the most effective pre-emptive measure to combat noise and ensure compliance with noise legislation. Counting on the expertise of an acoustic engineer and their active participation in decision-making processes regarding the choice of technologies, machinery and equipment to be used for

implementation from the early stages of the project definition process is critical in order to control on-site environmental noise.

- Taking the acoustic variable into account during the planning and scheduling of works minimises the acoustic impact generated during all building stages.
- Daily management and supervision of on-site works and an awareness by managers and workers of the need to reduce noise generation is fundamental in order to keep noise disturbance in neighbouring acoustic areas at its lowest.
- This is based on a real-life example of collaboration between a property developer, a building project drafting team, a contractor and an acoustic engineering firm in order to comprehensively manage environmental noise generated at a construction site. For this case study, proposed measures did not increase building costs and led to a noise level reduction of over 3 dBA.

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