ICSV13 - Vienna
The Thirteenth International Congress on Sound and Vibration
Vienna, Austria, July 2-6, 2006

# NOISE FROM CONSTRUCTION SITE: POINT OF VIEW OF A CIVIL CONTRACTOR

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## Abstract

This paper describes the contractor's approach to manage noise from construction site.
At preliminary design stage, construction activities and methods are analysed in order to anticipate noise from construction work. This analysis is useful to choose judicious equipment localisation, to limit noise propagation and to organize noisy operation.
The approach is based on a three step analysis.
A noise climate assessment of the area and an analysis of all equipment on site are the first step of this study. Then, the second step deals with the choice of the critical construction phases depending on the number of source, their sound power level, their activity and their position relatively to the noise receivers. Generally, a first estimation of noise at the plant site boundary is realised with analytical formula to determined critical phases.
The last step of this analysis is the noise map calculations in order to quantify and visualize noise around the site from all contributing sources at a given construction phase.
In addition, acoustic mitigation measures used on BOUYGUES TP construction site will be presented.

## INTRODUCTION

Environmental considerations take logically an increasing place in the civil works construction. Bouygues Travaux Publics, one of the major construction companies, has already included the environmental management in its in house procedures at each stage of the construction activities not only from the tendering period to the completion of work construction itself but also for the operating conditions.
As example, since few years, the company has developed its own methodology for management of reduction of noise on construction site.

After a presentation of this methodology in the context of a construction site, noise consideration during tender period analysis is leading to propose Clients best environmental offers.

## NOISE CONSIDERATION ON CIVIL CONSTRUCTION SITES

One of the characteristics of the civil construction is the outdoor location of the work. In fact this situation induces a larger expansion of the created noise to surroundings.

To answer this problematic, at least to use machinery in accordance with European noise legislation is the fist step of this action. But in fact, this is a necessary but not sufficient condition.

At preliminary design stage, noise predictions are conducted to access the magnitude of the noise from construction work.
Indeed, a specific analysis is required, particularly in urban areas, to choose judicious equipment localisation, limit noise propagation and organize noisy operation.

The methodology is based on a three step analysis. It comprised firstly, during preliminary design stage, the analysis of the noise standards for the project, and the determination of the character of the study area and its prevailing noise condition. In parallel, construction phases, corresponding equipment and possible locations of major activity sites are identified.

### 1st step: Site analysis

Noise standards or regulation related to construction works are slightly different in each country. Two aspects are dealt with, namely the acceptable noise level standard is dependent upon the character of the area within which the noise sensitive receiver is located (rural or urban area), and the time of day under consideration (day, evening, night) but current trends are to apply more stringent criteria due to the deteriorating noise climate.
In fact, the comparison with background noise level seems the best to estimate trouble for neighbourhood residents but the more complex to respect.
The background noise level is defined as the equivalent continuous A-weighted sound pressure level LAeq at a specific place and over a specific time inclusive noise resulting from only the intended activities in these space.

$$LAeq,T = 10\log(\frac{1}{\sum \Delta ti}\sum 10^{L_{pi}/10}.\Delta ti)$$

For that purpose, the existing noise climate of the study area is analysed in order to provide a reference base against which to relate the potential noise impacts of the project.

A site survey is conducted to determine the locations of existing noise sensitive receivers, which include residential properties, hotels, schools, clinics, places of worship and other uses requiring verbal communication, concert halls or amphitheaters within 500m from construction activities.

The physical noise levels and the nature of the noise climate are generally determined by the authority of the project by means of a field inspection and from a measurement survey. In particular case, complement noise measurement survey are done by the company to cover the whole area to assess the background noise level all around construction site and to focus specifically on potential noise sensitive/problem areas.

In parallel, sound power levels of outdoor equipments involve in potential working phases are precisely analysed. Noise levels created by operating construction equipment depend on factors such as type of equipment, the operation being formed, and the condition of equipment use. The equivalent sound level of the construction activity also depends on the fraction time that the equipment is operated over the time period of construction. Construction equipment operates in two modes, namely stationary and mobile. For the stationary equipment, noise is assumed to emanate from a single point of operation. Mobile equipment moves around the construction site with power applied in a cyclic fashion (bulldozers, loaders) or to and from the site (trucks), in these cases, the noise level is taken into account sometimes like traffic sometimes approximating a single point.
This analysis requires having a sufficient database to be able to model the relevant material in the adequate situation. Since many years from now, to complete equipment constructor data, BOUYGUES TP has built its own database with measurements on site including mobile material as well as static equipment such as, for example, concrete batching plant to allow representative preliminary calculations.

## 2nd step: critical phases identification

A first estimation of noise at the plant site boundary is performed with analytical formula (considering ground damping negligible) to determined critical construction phases regarding their activity or the equipment localisation relatively to the noise receivers and noise level criteria.
The formula used considering a hemispherical sound propagation in preliminary calculation is:

$$LAeq(d) = Lw - 10 \times \log(2 \times \pi \times d^2)$$

With d= distance and Lw the sound power level.

During this stage, the effects of different equipment localisation and construction method on the noise climate can be assessed in order to choice the best construction programme.

The following figure gives an example of this analysis done for a tunnel construction.

| Equipment | SWL (dBA) | Distance source-plant site boundary (m) | % exploitation day 7h-20h | % exploitation evening 20h-22h | Noise induced by the equipment at plant site boundary 7h-20h (dBA) | Noise induced by the equipment at plant site boundary 20h-22h (dBA) | Subtotal noise at plant site boundary 7h-20h (dBA) | Subtotal noise at plant site boundary 20h-22h (dBA) |
|---|---|---|---|---|---|---|---|---|
| Gantry | 95 | 105 | 100% | 50% | 46.6 | 43.6 | 66.1 | 63.1 |
| Generator | 95 | 107 | 100% | 50% | 46.4 | 43.4 | | |
| Compressor | 102 | 107 | 100% | 50% | 53.4 | 50.4 | | |
| Conveyor belt | 90 | 105 | 100% | 50% | 41.6 | 38.6 | | |
| Ventilation Fan | 108 | 105 | 100% | 50% | 59.6 | 56.6 | | |
| Water pump | 85 | 107 | 100% | 50% | 36.4 | 33.4 | | |
| Water pump 2 | 88 | 105 | 100% | 50% | 39.6 | 36.6 | | |
| Diesel Tarin | 108 | 107 | 100% | 50% | 59.4 | 56.4 | | |
| Mortar car | 108 | 107 | 100% | 50% | 59.4 | 56.4 | | |
| TBM | 109 | 107 | 100% | 50% | 60.4 | 57.4 | | |

*Figure 1 – Example of noise assessment for a sequence of a tunnel construction*

This type of analysis gives information to detect if mitigation measures are required and in which construction phases.

### 3rd step: Noise map calculations

The last step of this analysis is the noise map calculations in order to quantify and visualize noise around the site from all contributing sources (static and mobile) at a given construction phase.
The software used is MITHRA® developed by the CSTB, a National French laboratory for environmental and Building acoustics. MITHRA® is software dedicated to sound propagation modeling in 3 dimensions. It considers the most important variables for a given site such as building layout, topography, noise barriers, ground type, and meteorological effects.
This type of software required detailed sound power level information for each equipment such as spectrum information. For the major party of time, this information coming from our data base because it is very rare to find it in equipment constructor guideline.
The calculation method used is ISO9613 based on standard ISO9613-2.

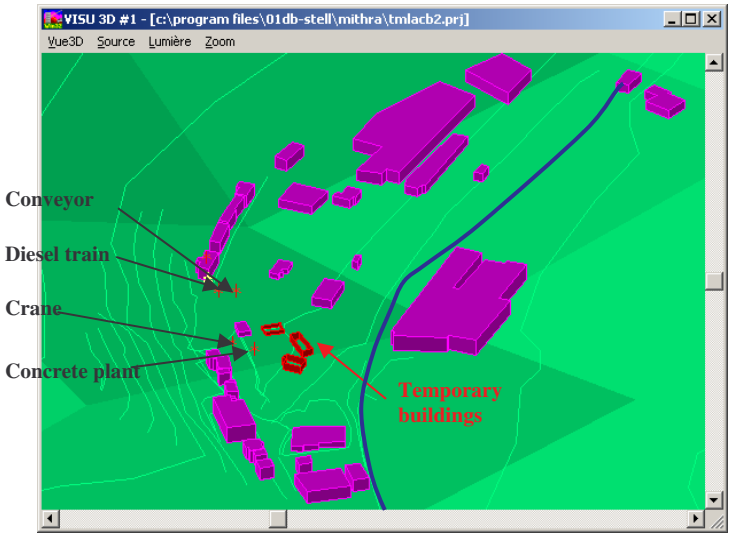


*Figure 2 – Example of a construction site*

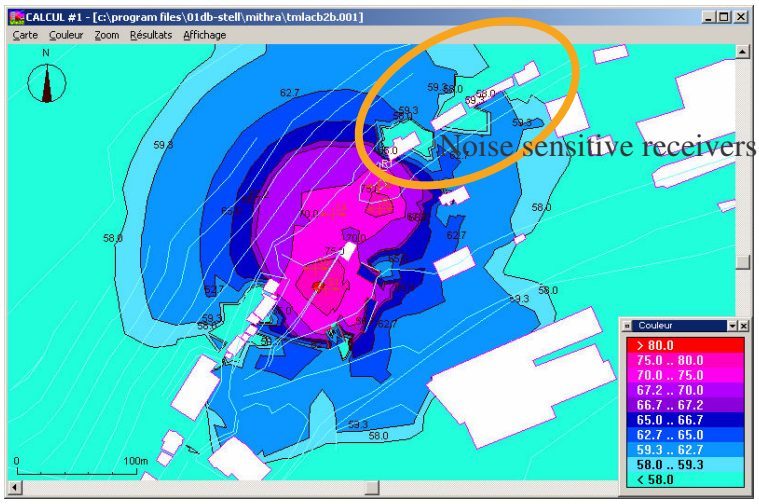


*Figure 3 – Example of a horizontal noise map*

This calculation gives the best representation of the noise impacts on the different noise sensitive receivers.

If needed, noise barriers could be designed and optimized in order to reach an acceptable level of noise near the most noise sensitive receivers.

## NOISE CONSIDERATION DURING TENDER PERIOD

Prior to construction, Contractors have, during the tender period, to make a preliminary assessment of the noise impact in order to cope with environmental constraints and regulations.
Compared to the previous subject, in this case, the problematic is double:

- first one have to assess possible various construction sequences associated to adequate selection of working material
- then from this proposed set, to make a comparative prevision of the noise impact of each of them, including possible mitigation measures.

With adequate data base on noise climate and equipments, all aspects of the potential construction modus operandi impact can be anticipated and appropriate mitigation measures recommended on construction techniques, delivery routes, location of construction camps and work programme.
From the comparisons between the various scenarios, a final selection is done for the company offer representing the best technical and economical compromise for the concerned project.
For example, this type of analysis have led us to define a solution of supply by railway instead a solution by trucks which would generates, on the day, least sound impact on houses surrounding the construction site.

# NOISE CONSIDERATION TO COMPARE ALTERNATIVE SOLUTIONS

Based on the large experience of the Technical Department of BOUYGUES TP on many fields of the civil construction, the company can propose in a design and build contract, technical alternative in order to offer Client optimised structural conceptions which are not only economically interesting but which noise impact has been also assess and represents an equivalent and even a better noise management.
For example, two vertical railway alignments can be studied to compare both solutions in terms of noise propagation and protection measures. This analysis has just been done to assess the technical alternative proposal in elevated viaduct compared to an open cut alignment.

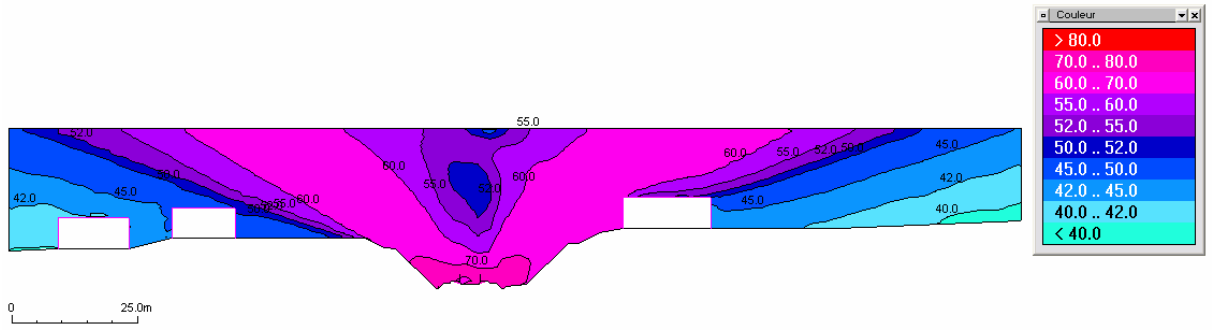


*Figure 4 – Example of a vertical noise map of a railway in open cut (without noise barrier)*

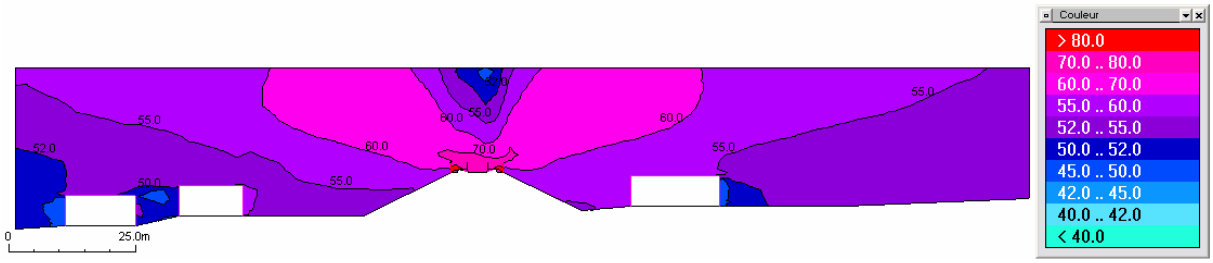


*Figure 5 –Example of a vertical noise map of a railway on elevated viaduct (with a 2m high noise barrier)*

## SUMMARY

This methodology gives elements to demonstrate the respect of the regulation, to limit nearby resident complaints and facilitate public understanding.
We need sufficient complete information during the tender on noise climate in the concerned construction area to allow us to take into account the noise aspect, and choose adequate construction method not only regarding the project but also regarding noise impact.
The second point is the necessity of more precise information on sound power level from suppliers of material (fixed or mobile) in their documentation (with all the detail of the range of frequency required, as well as for the mobile machines, the noise in movement and\or in "standard" operation).