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## **Industrial Sources of Pollution by Vibrations – Causes and Behavior**

*Pollution by vibrations caused by industrial sources is extremely unpleasant if in their proximity are build areas. The authors present a classification of this kind of sources and the way how the vibrations are produced and propagated. Parameters of vibrations, their attenuation trough the ground and impact on the build structures is also illustrated.*

### **1. Introduction**

The aim is the adoption and implementation of solutions to decrease pollution produced by sources which produce often simultaneous noises and vibrations and it's effects on the urban environment and the population. There are norms and standards which indicate the maximum level of noises and vibrations for different intensities or exposed time. To reduce the risks of exposure to vibrations or noise is not optionally, but it is a priority in the European policy (ex. Directive 2002/44 CE and Directive 2002/49 CE).

### **2. Actual Stage in Romania**

Until now, in Romania have been made punctual measurements, on local level (București, Timișoara, Reșița, Galați, so.), for following cases: determination of the vibration exposing level for buildings in urban area close to industrial platforms by punctual measurements; determination of the noise pollution level resulted from urban traffic in zones situated close to airports and roads with high traffic.

Also the process of collecting data regarding the exposure level for noise and vibration, and some maps based on this data have been done, but for very small areas. This took in consideration just noise resulted from urban road traffic and not from industrial sources (equipments and processes) with a high level of noise and vibrations. The measurement systems used by the determinations were manually, involving long operating periods (measuring, monitoring, processing and analysing), being laborious and with low productivity. However, the accumulated experi-

ence consist an important resource that can be used at a higher level in terms of this project.

The evaluation and control of environmental noise which affects the population is under the responsibility of the central and local public authorities conform with HG 321/2005 (adopting Directive 2002/49 CE), with clear attributions and responsibilities. Also HG 321/2005 as well "Legea protecției mediului nr. 137/1995" (Law for Environmental Protection no. 137/1995) marks the attributions to the "Agenția Națională pentru Protecția Mediului" (National Agency for Environmental Protection). The activities that have to be done by the mentioned authorities are: concealing at different levels (local, regional, national); elaboration of regulations and necessary guides; territorial identification of noise sources; centralization at regional and national level; elaboration of action plans; reporting at European level. Some issues have been approached, without a centralized, coherent set of actions.

The limitations of dangerous vibrations transferred to the urban buildings is regulated in our country through the norm STAS 12025/1/2 from 1981 ("Efectele vibrațiilor asupra clădirilor sau părților de clădire" – Effects of vibration on buildings or building components), and at international level through the norms ISO 4866 from 1990 ("Mechanical vibrations and shock. Vibrations of buildings – Guidelines for measurement of vibrations and evaluation of their effects on buildings") in which refer to German norms DIN 4150/1/3 ("Vibrations in buildings; principles, predetermination and measurement of the amplitude of oscillation").

Researches done until now in our country are based on procedures harmonized on the European directives being mostly orientated to evaluation and analysis of the performance of the protection systems and rare to the exposed noise and vibration level.

### **3. National Network for Implementation of European Directives**

The obtained results can be taken over as a starting point for a complex research which we intend to develop in frame of a project. It is necessary to create a partnership/network involving Research institutes, Universities, Independent Laboratories which can assure a good territorial coverage and have the competence to finalize specific tasks. Near this, different firms which offer convex services (for ex. digital cartography), will be implicated and so stimulated to extend their offer of services. This collaboration follows to reach the project but also the developing of a durable public private - partnership.

During the run of the proposed (pilot) project the partners will get specific duties. First, the coordinator at regional level collects the official statistic information and those obtained from the accredited laboratories for each domain (through measuring, monitoring and processing) to an initial estimation, and transmit the final results, processed, to centralize at the data base administrator. Documenta-

tion concerning standard measuring methods for correct utilization of modern equipment and data processing for software will be realized through normative and documentation study, laboratory authorization a.o. followed by working meetings between partners. Also will be established the relevant location for monitoring. It will be used relevant documents (statistics, technical data, standards) and ICT.

Depending on geographic distribution and specialization, applying function analysing method, it will be form the network structure (research teams and managers, general coordinating structure of the project a.o.) being encourage the working team and young research implication. Using techniques for creative stimulation will be found the best solution concerning the content of measuring system and techniques. Laboratory's equipment and software (based on methodology acquisition from the project) will be acquired respecting the necessity and the fair territorial distribution.

Data acquisition, monitoring, transfer and processing will be made conform to the proposed methodology, aimed the testing of the system's functionality as well as the compatibility with other system's which can benefit of the results (ex. realization of acoustic map).

Complex network validation (measuring, monitoring, processing and storage of data) and the working procedures is making through two ways: alternative measures in original point of measure and other measuring points and comparison with calculus results, seconded by statistic analysis for errors control and predictions.

An important element, the project impact will be made through workshop's and science shops and participation to the specialized conferences for dissemination of results and methods.

The project intends to be an example of good practice in the field of implementing European regulations, a guide for public authorities, educational institutions, firms, NGOs and public society.

We designed four steps for the project's implementation, each step contain a number of phases in concordance with its complexity.

The achievement scheme is presented in next section.

STEP 1 – Analysis of legislation, standards and norms (on National and European level), elaboration of a solution study for the realization of a system for acquisition and processing of data

- Phase 1 – Documentation regarding demands of application for HG 321/2005 and Directive 2002/49CE, specific standards and norms and elaboration of a solution study for the realization of a system for acquisition and processing of data

STEP 2 – Fixing the working method by data acquisition trough measurements and monitoring of the level of vibration and noise by elaboration of working procedures for the subsystems of the network. Design of the network system for measurement&monitoring and of the database.

- Phase 2 – Elaboration of working methods for determination of noise and vibration level (punctual measurements, permanent and periodical monitoring, data processing and transfer to the database)
- Phase 3.1 – Design of the network system for measurement – monitoring composed by the subsystems dedicated to vibrations and noises
- Phase 3.2 – Design of the database and the connections to the measurement points

STEP 3 – Realization of the subsystem of the network dedicated for measurements & monitoring of noise level produced by industrial sources. Realization of the network's subsystem dedicated for measurements & monitoring of the vibration level transferred by industrial sources to buildings situated in the urban area. Realization of the database. Testing and proofing the functionality of the integrated system for a limited number of locations and eventual corrections regarding the network or the procedures.

- Phase 4.1 – Realization of a subsystem for measurement & monitoring of noises produced by industrial sources
- Phase 4.2 – Realization of a subsystem for measurement – monitoring of vibrations transferred from industrial sources to urban buildings
- Phase 4.3 – Connection of subsystems to the center for data processing and to the database. Testing of the system's functionality.

STEP 4 – Promotion activities of the results through large dissemination and demonstration of the system's functionality. Transfer of IP to the partners.

- Phase 5.1 – Large dissemination of the results and technological transfer
- Phase 5.2 – Demonstration of functionality
- Phase 5.2 – Transfer of IP to the partners.

Duration of the pilot project should be 18 months, followed by extending the network to cover the whole territory of Romania. As first results we expect to have an image about pollution with noise and vibration, in several locations in Romania, a noise map and databases for public use regarding this kind of pollution but also the regulations on European level.

#### **4. Assessment and Management of Environmental Noise**

This Directive *shall apply* to environmental noise to which humans are exposed in particular in built-up areas, in public parks or other quiet areas in an agglomeration, in quiet areas in open country, near schools, hospitals and other noise sensitive buildings and areas. It *shall not apply* to noise that is caused by the exposed person himself, noise from domestic activities, noise created by neighbours, noise at work places or noise inside means of transport or due to military activities in military areas.

The aim of Directive 2002/49 CE shall be to define a common approach intended to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise. To that end the following actions shall be implemented progressively:

- the determination of exposure to environmental noise, through noise mapping, by methods of assessment common to the Member States;
- ensuring that information on environmental noise and its effects is made available to the public;
- adoption of action plans by the Member States, based upon noise-mapping results, with a view to preventing and reducing environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health and to preserving environmental noise quality where it is good.

It shall also aim at providing a basis for developing Community measures to reduce noise emitted by the major sources, in particular road and rail vehicles and infrastructure, aircraft, outdoor and industrial equipment and mobile machinery. It's expected that the Commission will submit to the European Parliament and the Council, no later than 18 July 2006, appropriate legislative proposals.

The directive defines four types of noise indicators:

- $L_{den}$  (day-evening-night noise indicator) shall mean the noise indicator for overall annoyance, and is defined as:

$$L_{den} = 10 \lg \frac{1}{24} (12 \cdot 10^A + 4 \cdot 10^B + 8 \cdot 10^C) \quad (1)$$

where

$$A = \frac{L_{day}}{10}, \text{ Error! Objects cannot be created from editing field}$$

$$\text{codes. and } C = \frac{L_{night} + 10}{10} \quad (2)$$

- $L_{day}$  (day-noise indicator) is the A-weighted long-term average sound level determined over all the day periods of a year. The day period is considered 12 hours in the period of 7,00 – 19,00 ;
- $L_{evening}$  (evening-noise indicator) is the A-weighted long-term average sound level determined over all the day periods of a year. The evening period is considered 4 hours in the period of 19,00 – 23,00 ;
- $L_{night}$  (night-time noise indicator) is the A-weighted long-term average sound level determined over all the day periods of a year. The evening period is considered 8 hours in the period of 23,00 – 7,00 .
- limit value shall mean a value of  $L_{den}$  or  $L_{night}$ , and where appropriate  $L_{day}$  and  $L_{evening}$ , as determined by the Member State, the exceeding of which causes competent authorities to consider or enforce mitigation measures; limit values may be different for different types of noise (road-, rail-, air-traffic noise, industrial noise,

etc.), different surroundings and different noise sensitiveness of the populations; they may also be different for existing situations and for new situations (where there is a change in the situation regarding the noise source or the use of the surrounding)

## 6. CONCLUSIONS

The impact of vibration and environmental noise can have harmful effects on human health and well-being. A sustainable society should offer a mix of main urban functions such as housing, work and mobility without exposing citizens to high vibration and noise levels.

Simple adoption of regulations and norms don't assure this requirements, important is on one side to establish a network with specific competences, and on the other side the will of public authorities to use this competences.

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