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NOISE AND VIBRATION PROTECTIVE SOLUTION ANALYSIS FOR TECHNOLOGICAL EQUIPMENTS

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ABSTRACT

This paper presents a cumulative and comparative analysis, concerning the noise and vibration pollution and protective approaches, monutoring the construction technological equipments. By means of the computer simulations, validated with the instrumental tests, it was shown the high level of the pollution essential parameters, and the way by it affects both the environment, and the human operators of the machines.
The comparative analysis of technical solutions for noise pollution reduction in equipments cabins was made and underlined for three examples of construction equipments, as follows: multi-purpose equipment MMT45, excavator S1201 and automotive soil compactor CVA10. These were adopted according to a general coverage of the entire construction equipments class. Thus, the first equipment represents the medium capacity class, for interventions on closed spaces, and with a high level of capability and efficiency.

KEYWORDS: Noise, Pollution, Acoustic, Cabin, Isolation.

1. Introduction

The main purpose of the study is naturally completed by establishing the real way of function of the protective systems used for sound absorbing and isolation treatments, and for the anti-vibration isolation of the cabins of technological equipments. While some technologies use the vibration benefits, and, because the noise is a direct result of many of the technological processes, the right way to reduce the pollution level is to butt in the receiver tag.

From this analysis, a few major conclusions result bering a direct application on techniques and systems for pollution reduction. One of the main concluding remarks is the global dose of noise and vibration pollution, which is able to perform and supply an absolute characteristic of the dynamic isolation.

The comparative analysis of the technical solutions in order to reduce noise level in the control cabin of the technological equipments was realized and substantiated on three real examples of construction machines: the multi-purpose equipment MMT45, the excavator S1201 and the automotive vibratory soil compactor CVA10.

The characterization and comparative analysis was performed by means of the next parameters evaluation:

- the absorption constant R,
- the total level of noise reduction parameter ΔL,
- the average acoustic absorbtion constant αm.

For facilitating the comparative analysis, there were adopted the following basic ideas referring to the evolution of the three parameters and the way of their graphic representation for the four cases of acoustic isolation and for the three analyzed technological equipments

- the parametric representation of the evaluated measures (ΔL, αmed, R), according to the number of acoustic absorbing layers, for each type of equipment;
- the parametric representation of the evaluated measures according to the type of equipment for each case of isolation (the number of acoustic absorbing layers);
- the parametric representation according to the number of acoustic absorbing layers, to the relative gain of the absorption constant R, and of the average acoustic absorbtion constant αmed. In this case, the parameter that represents total level of noise reduction was omitted because its evolution respects, from the qualitative point of view, the evolution of the average acoustic absorbtion constant αmed;

All the graphic representations were realized according to the frequency. The value of the three essential parameters were evaluated for the next range of work frequencies: 250, 500, 1000, 1600, 2500 Hz.

The numerical value set used as entering data for this analysis is presented in Table 1.

Table 1. The input values for evaluation of noise reduction performances.

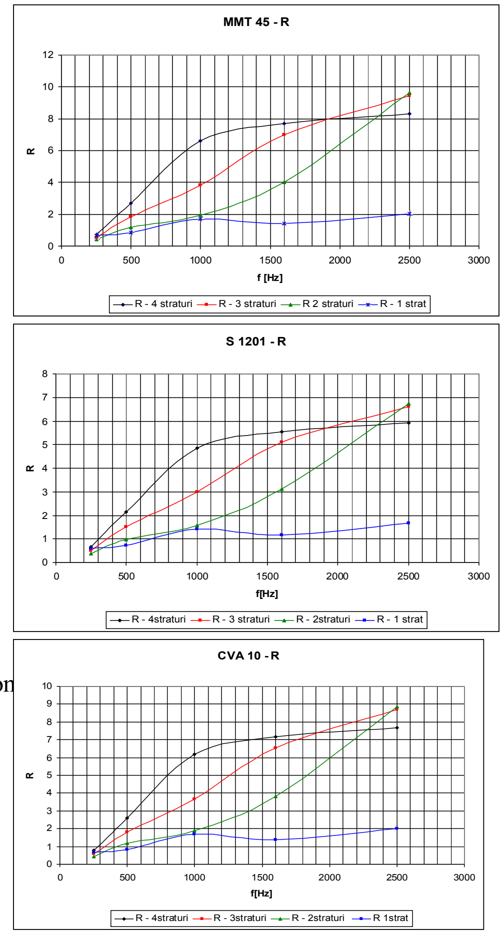
Input essential parameters vs. type of technological equipment	Geometrical surface with sound absorbing treatment S_1	Metal surface without sound absorbing treatment S_2	Windows surface S_3
Multi-purpose equipment MMT 45	4.7 m^2	1.7 m^2	3.8 m^2
Excavator S 1201	3.8 m2	1.2 m2	5.1 m2
Automotive vibratory soil compactor CVA10	4.5 m2	2.1 m2	2.2 m2

2. Experimental Results

Taking into account those exposed during the previous paragraphs, in Figures 1..3 there are presented the variation diagrams of the absorption constant R, of the total level of noise reduction parameter ΔL and of the average acoustic absorbtion constant αm.

From the comparative analysis of the three sets of diagrams (see Figures 1..3) the following conclusions are drawn and they refer to the evolution and behavior of the acoustic structures used for noise insulation of the technological equipment cabins.

For each of the three considered parameters the limitation of the maxim values alongside with the increase of acoustic absorbing layer number is observed; the limitation of the maxim values is obvious for the values of the superior frequencies of 1000Hz.



(a) multi-purpose equipment MMT 45

(b) excavator S1201

(c) automotive vibratory soil compactor CVA 10

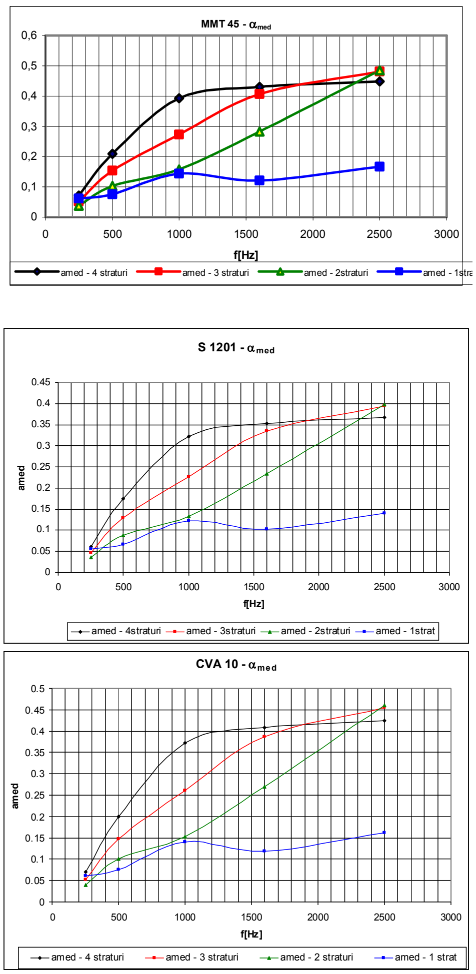
Figure 1. Variation parametric diagrams for the absorption constant R

In the superior zone of the analyzed frequency domain (over 1000Hz) a four times increase of the absorption constant R value is noted, in comparison with the considered limit situations of single layer and quad layers of acoustic isolators.

Also, for the same frequency zone (over 1000Hz) the doubling of the values for the other two parameters is observed (the total level of noise reduction parameter ΔL and the average acoustic absorbtion constant α_m) for obvions single-layer situations with single layer and quad layers acoustic isolation setup.

In the inferior zone of the analyzed frequency domain (under 1000Hz) the analyzed parameters have an approximate linear evolution, the values of these increasing along with increasing the frequency.

For the value of 250Hz an insignificant contribution is noted in the isolation of noise according to the used number of isolation layers



(a) multi-purpose equipment MMT 45

(b) excavator S1201

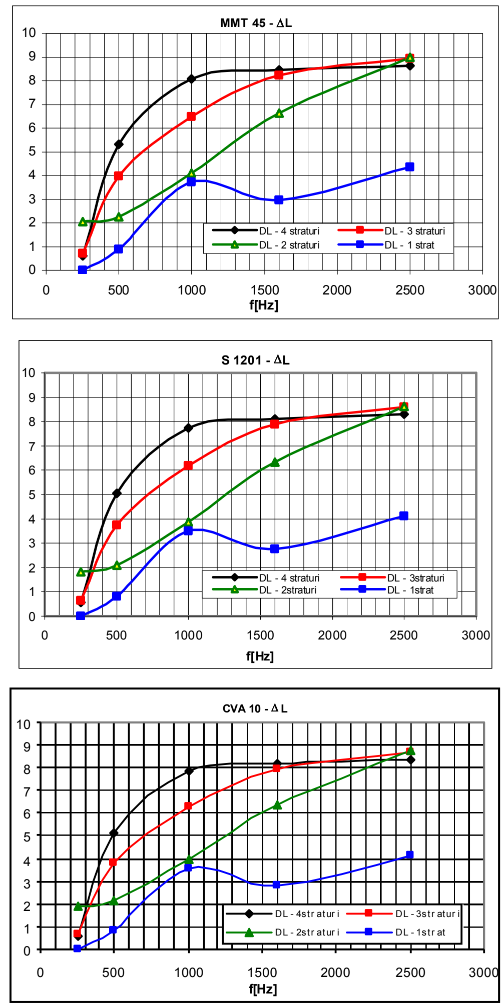
(c) automotive vibratory soil compactor CVA 10

Figure 3. Variation parametric diagrams for the average acoustic absorbtion constant αm

If the evolutions of the three parameters (ΔL, αmed, R) are analyzed comparatively, for each type of acoustic isolations (according to the number of acoustic absorption layers), it is observed that the qualitative and quantitative variations of those are dependent only on frequency and on the type of insulation.

Although they were considered technological equipments which are part of distinct categories, the differences between the obtained values for each analyzed case can be considered negligible, having maxim percentage values of under 30 % for the maxim frequency of the analyzed spectrum (2500Hz). This can be observed in the diagrams depicted in Figures 4..6.

While some technologies use the vibration benefits, and, because the noise is a direct result of many of the technological processes, the right way to reduce the pollution level is to butt in the receiver tag.



(a) multi-purpose equipment MMT 45

(b) excavator S1201

(c) automotive vibratory soil compactor CVA 10

Figure 2. Variation parametric diagrams for the total level of noise reduction parameter ΔL

The efficacy of this intervention has to be conceived and evaluated through a simple manner, with a single parameter, and in a proper way, to facilitate the inclusion into the pollution reduction management procedures.

The contribution of this work consist in the global characterization means, for noise and vibration concurreat pollution, developed and applied on a group of construction technological equipments. From that analysis, a feur major conclusions result bearing a direct application on techniques and systems regarding pollution reduction.

One of the main concluding remarks is the global dose of noise and vibration pollution, which is able to perform and supply an absolute characteristic of the dynamic isolation.

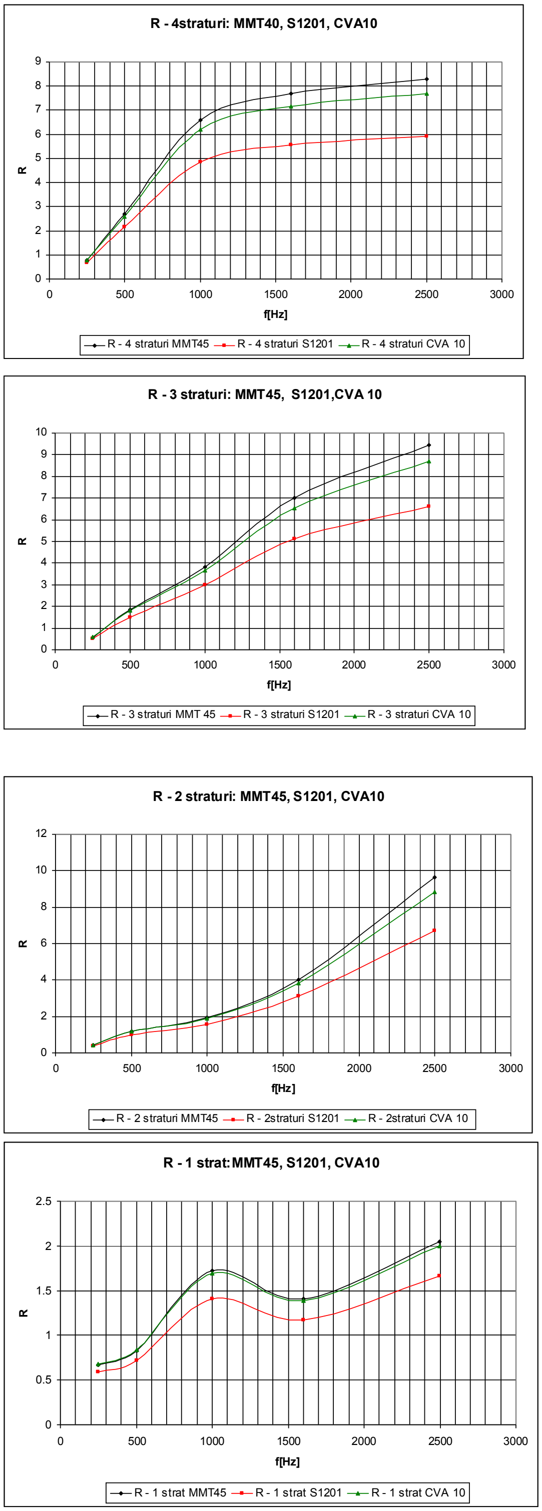


Figure 4. Comparative parametric diagrams for the absorption constant R as a function of technological equipment type

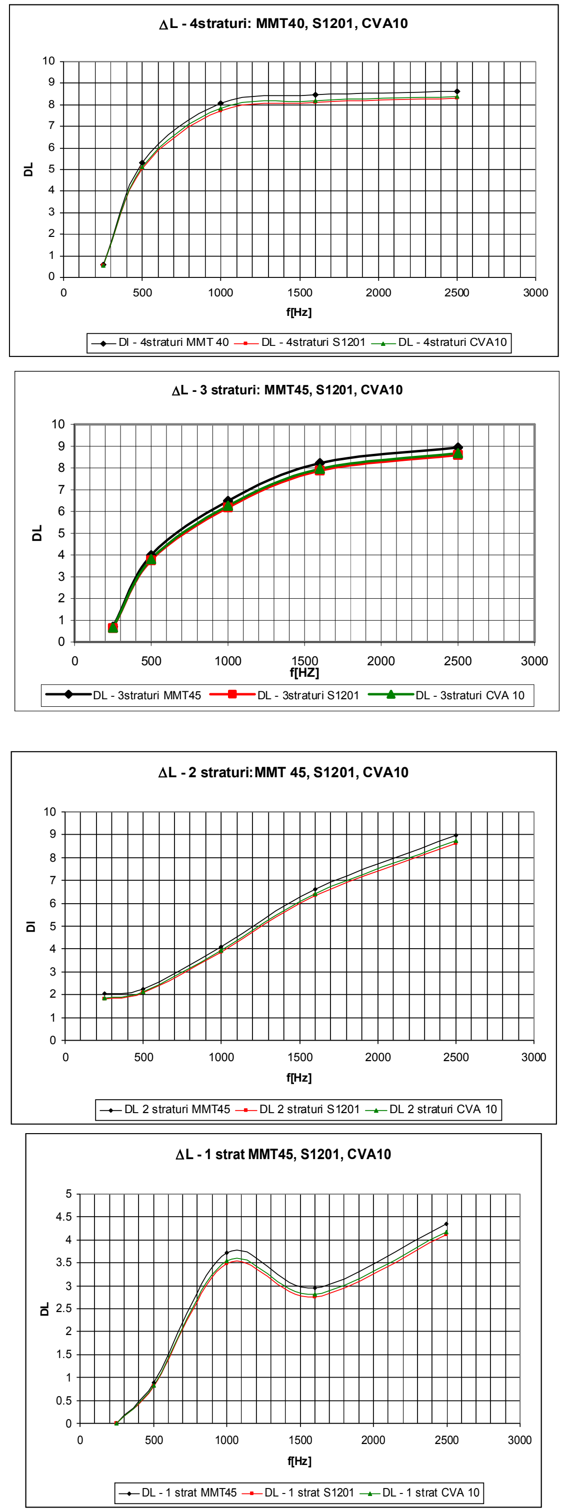


Figure 5. Comparative parametric diagrams for the total level of noise reduction parameter ΔL as a function of technological equipment type

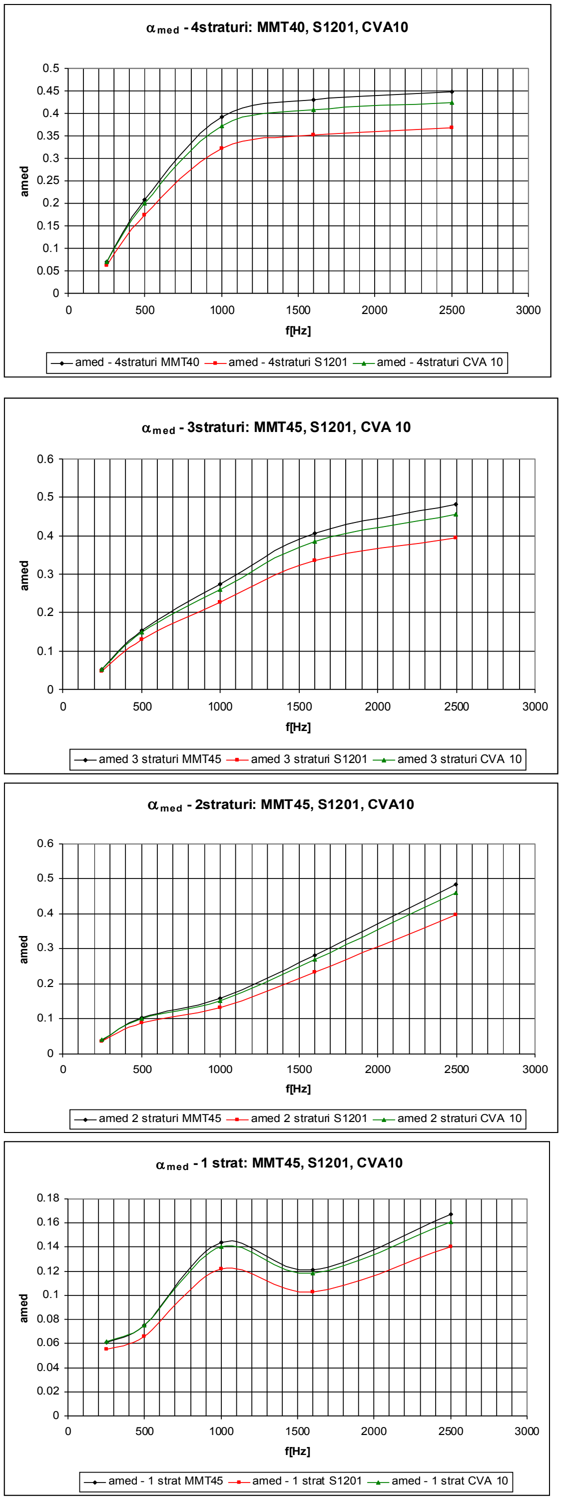


Figure 6. Comparative parametric diagrams for the average acoustic absorbtion constant α_m as a function of technological equipment type

A study heen performed on the acoustic absorption coefficient variation for sound absorbing structures and materials considering three construction equipments has been performed. The sound material has been considered from one to four layers.

Different values have been determined for:

R - absorption constant,

ΔL - global noise reducing,

α_{med} - sound absorbing average coefficient.

The task of this work is the acoustic absorption coefficient variation study of sound absorbing structures and materials.

Three construction equipments have been considered according to their different cabin design. Different sound frequencies and different layers of diverse sound absorbing treatment have leid to different absorption average coefficient values.

The experimental validations of these results completes the whole assembly of research, sustains the correctness of the initially adopted ideas and obviously, precisely and for realy establishes the basis of using the global dose of pollution through the simultaneous and combined effect of vibrations and noise.

Eliminating the structural-functional details specific to the system of attenuation/elimination from the procedure of analysis of the isolating performances leads directly to the reduction of the necessary calculation complexity and of the time destined to qualitative and quantitative characterization of a technical solution in order to cutdown the level of pollution through sound and vibration.

The main argumentations enframed in previous paragraphs lead to the main concluding remark: this study has a general character with reference to noise pollution level reduction, the final results being applicable for any types of technological equipments which require insulation on the cabin.

3. Conclusions

This study is a general approach of the sound pollution decreasing concept; the results can be taken into account in the situation of technological equipments noise isolation. The formulation of the general conclusions of this study must take into consideration both the degree of fulfillment of the general purpose and the partial conclusions obtained during the research stages.

First, it has to be mentioned the conformity of this study, through its initial objectives, adopted methodology and the final results according to the national and international requests.

By means of the computer simulations, validated by the instrumental tests, the ligh level of pollution essential parameters was shown, as well as the way it harms hoth the enviroument and machine human operator.

While some technologies use the vibration benefits, and, because the noise is a direct result of many of the technological processes, the right way to reduce the pollution level is to butt in the receiver tag.

The assembly of the specific features of the sound and vibration pollution levels, in a single general indicator generically named the global dose of noise and vibration pollution, represents the basic element of the study.

In the evaluation of this indicator, using the global levels of characterization, both for sound pollution, and for the vibration pollution, develops the analysis capacity at the level of a general assembly, without involving the detailed study of the structural components

Hereby, this new concept represents the initial point for a unitary method of evaluation for the levels of noise and vibrations emitted for the exterior level of noise and vibrations emitted by the construction machines, spatially adjacent to the zone of development of the technological process with a direct impact on the advanced evaluation and analysis of bad emissions, of the protective technical means (eliminating or diminishing the pollutant effects) and of the cumulated effects on the human factor and/or of some technical equipments susceptible to such pollutant factors.

For a whole variety of machines and technological equipments, the conditions of some comparative characterization and complete classification are created from the point of view of the technological stress reduction induced by noise and vibrations, of all the considered systems.

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