ADVANCES ON NOISE AND VIBRATION PROTECTION AT TECHNOLOGICAL EQUIPMENTS

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Abstract: This paper presents a cumulative and comparative analysis, concerning the noise and vibration pollution and protective approaches, at 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 through these affects both the environment, and the human operators of the machines. While some technologies uses 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 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 by the global characterization means, for noise and vibration concurent pollution, developed and applied on a group of construction technological equipments. From this analysis results a few major conclusions with 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.

1 Introduction

This research gathers a great variety of results, both theoretical and experimental, with the final purpose of completely characterizing the ability to protect the machine operators from noise and vibration in the field of mechanized technologies for constructions. This 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 at technological equipments.

The global approach of the whole set of research, with examples on important and relevant technological equipments, the basis of these studies on the type and structure of the disturbing actions, the establishment of the analysis and characterization criteria on the reducement effects and measures of these on the workers are essential points in formulating and sustaining the innovative concept of the global dose of noise and vibration pollution (GDNVP). The assemblage of global dose of noise and vibration pollution presumes the settlement of essential elements, which together can provide the opportunity of a complete characterization for the phonic and vibratory pollution level. Regarding the noises, the weighted equivalent noise level can assure total the previous requirement. For vibration level it was started from the measurement at the handling or support elements existing in the cabin.

Supposing a larger or a closer number of parameters for GDNVP, it will be obtain extended or concise formulations. Each of them have advantages or not, and will be used as a function of real situation and concrete requirements. The closer formulation provides a synthetic expression, with a maximum level of generalization, at the same time it was loosed some particular data regarding the equipment handling characteristics. This paper briefly presents some of interesting and relevant results, and two relevant formulations of GDNVP.

2 Global dose of noise and vibration pollution

The comparative analysis of technical solutions for noise pollution reduction in equipments cabins was maded 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, first equipment represents the medium capacity class, for interventions on closed spaces, and with a high level of capability and efficiency. The second is large capacity equipment, intended for open spaces works. The third equipment has the working state based on vibration utilization. The characterization and comparative analysis was performed by the means of the next parameters evaluation: the absorbtion constant $\boldsymbol{R}$, the average acoustic absorbtion constant $\boldsymbol{\alpha_{med}}$, and the total level of noise reduction parameter $\boldsymbol{\Delta L}$. In Table 1 is presented the input values used for evaluation of these parameters.

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

	Geometrical surface with sound absorbing treatment $\boldsymbol{S_1}$	Metal surface without sound absorbing treatment $\boldsymbol{S_2}$	Windows surface $\boldsymbol{S_3}$
Multi-purpose equipment MMT 45	4.7 m^2	1.7 m^2	3.8 m^2
Excavator S 1201	3.8 m^2	1.2 m^2	5.1 m^2
Automotive vibratory soil compactor CVA 10	4.5 m^2	2.1 m^2	2.2 m^2

2.1 Some aspects regarding the noise pollution

For each of three equipments it was considered four analysis cases, related to single, double, three, and four layers of composites for noise isolation and absorbtion. The evaluation of noise reduction parameters ($\boldsymbol{R}$, $\boldsymbol{\alpha_{med}}$, $\boldsymbol{\Delta L}$) was performed for a frequency band between 250 and 2500 Hz, where the efficacy of classical solutions is poorness affected.

The analysis of the results leads to the next partial conclusions: first, the total level of noise reduction parameter $\boldsymbol{\Delta L}$ have an evolution relative like the average acoustic absorbtion constant $\boldsymbol{\alpha_{med}}$, and second, the absolute values of these parameters have not a major significance for comparing analysis and capability estimations of noise reduction technical solutions. Thus that, based on these remarks, it was holded only two parameters ($\boldsymbol{R}$, $\boldsymbol{\alpha_{med}}$) and it was evaluated the relative gain for these, than percentage, taking the reference value that coresponding of a single layer case. In Figure 1 is depicted the final diagrams of percentage relative gain for the absorbtion constant $\boldsymbol{R}$, and respective for the average acoustic absorbtion constant $\boldsymbol{\alpha_{med}}$.

2.2 Some aspects regarding the vibration pollution

The spectral characteristic of acquired acceleration signals provide enough information concerning the vibration level transmitted to the human operator. The accelerations for the three orthogonal directions were measured at the steering wheel, at handlers, on the chair seat and on the cabin floor. The instrumental tests were performed with unloaded equipment engine and at 2/3 of maximum engine speed. The final holded values was obtained through a comparative analysis between the two cases, with systematic estimations of dissipation degree and prevailing frequencies area, and taking into consideration each working cycle configuration. It has to be mentioned that the vibratory analysis and the assemblage of GDNVP's was maded with four types of technological equipments, also with general coverage of construction equipments class.

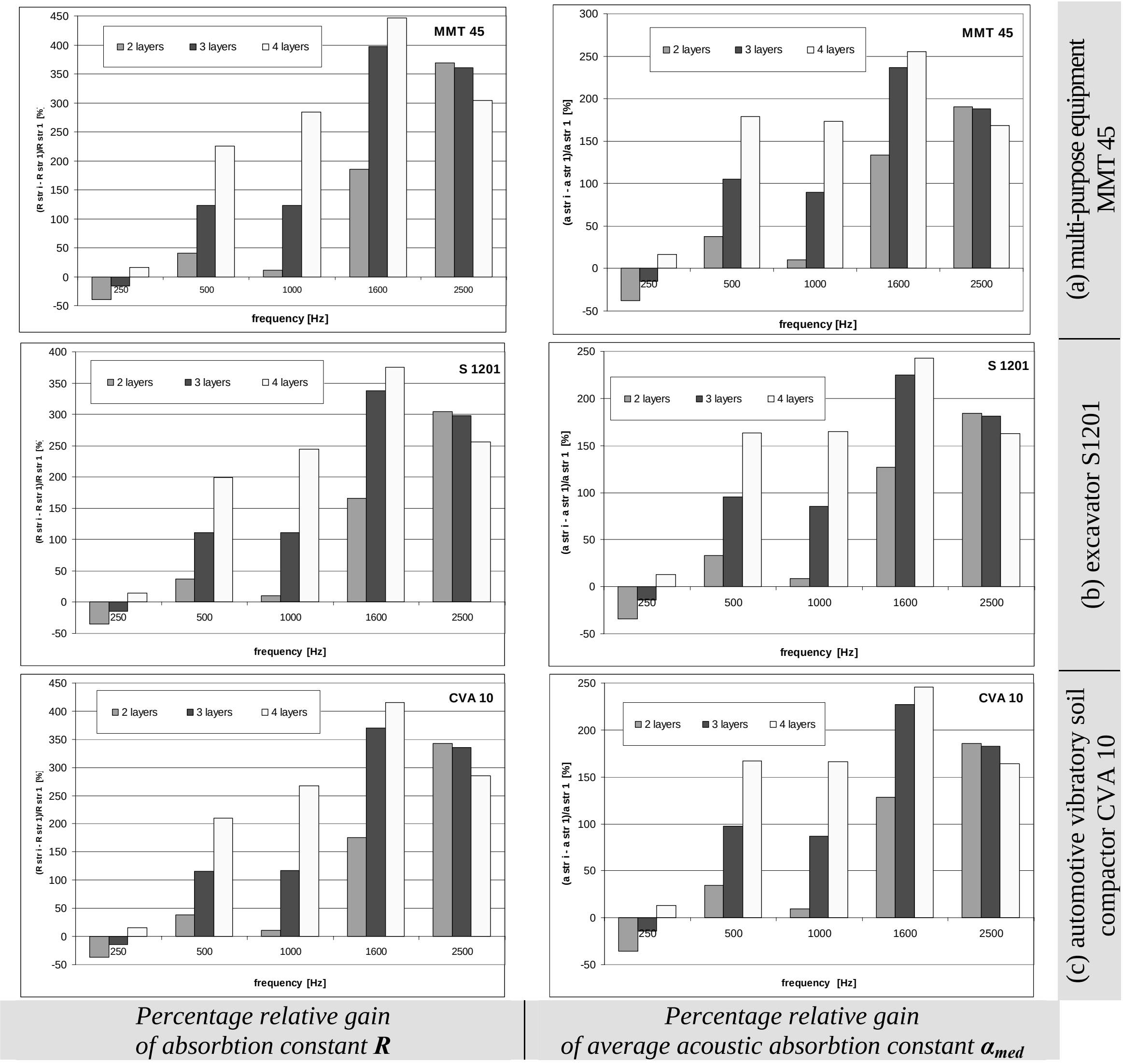

Figure 1. The variances of percentage relative gain.

Table 2. The shortened form of global dose of noise and vibration pollution.

equipment type		*u.m.*	*measurement place*			
			at the wheel	*handle*	*seat*	*floor*
Vibratory soil compactor	a_t	m/s^2	**10.0391**	**-**	**5.2536**	**3.5887**
ABG DD16	L_{Am}	dB(A)	**83.8**			
Excavator	a_t	m/s^2	**0.7071**	**9.8873**	-	-
Pelican	L_{Am}	dB(A)	**74**			
Wheel loader	a_t	m/s^2	**0.7693**	**0.7185**	**0.1726**	**0.4280**
KOMATSU WA 270	L_{Am}	dB(A)	**73.8**			
Dozer-excavator	a_t	m/s^2	**1.2156**	**9.8873**	**0.5535**	**1.6081**
KOMATSU WB 93R	L_{Am}	dB(A)	**76.8**			

2.3 Short expression of GDNVP

The authors were evaluated different expressions for GDNVP, more or less complex regarding the configuration of the structural parameters. Basically, the GDNVP is composed by weighted equivalent noise level and acceleration levels for each handling or support elements, and for the three orthogonal directions. Structural differences results from number of the parameters which describe the vibration pollution levels, as follows: for each direction, for unloaded or loaded engine, for each handling and support element of human operator.

In view of settle a suitable single parameter regarding the level of vibration it was evaluated the total acceleration level for each measurement point. Hereby, the concise form of GDNVP contains the weighted equivalent noise level in cabin and the total acceleration level for each handling or support devices (see Table 2). This final expression keeps both the handlers, and support elements separately, because of the main purpose to dignify the private character of each technological equipment.

3 Conclusions

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. Taking into consideration separately the contribution of each results set, the theoretical analysis of the sound waves effect inside the cabins of the construction machines, the results of the modeling and theoretical simulations, together with those of experimental determinations, both based on objective criteria established according to the psycho-sensorial and physiological effects of sound and vibrations on man, substantiated and justified on the specific requests of man protection from noise and from vibrations, fully justifies the necessity, the opportunity and the importance of this research. Through the simplicity versus the power of conciseness in global characterization of noise and vibration pollution levels, the GDNVP, with any of structural configurations, fully provide a useful and suitable tool for analysis and characterization of human operator protection against harmful actions of noise and vibration.

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