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# RESEARCHES ON THE ACOUSTIC TREATMENTS WITH COMPOSITE MATERIALS PANELS AT THE FRONTAL LOADER MMT45

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## ABSTRACT

*The article presents the problem of the testing of some protective systems made of PU foam based composite materials which can simultaneously meet the following requirements: noise absorption for middle and high range frequencies, noise insulation for low frequencies, vibration damping in order to avoid noise transmission by structure. There are presented experimental data of the efficiency of the acoustic treatment applied for the cabin of the Romanian frontal loader MMT45.*

KEYWORDS: composite materials, noise absorption, noise insulation, vibration damping

## 1. INTRODUCTION

The scope of using composite materials for the acoustic treatments of the self propelled technological equipment is to decrease global level of noise and vibration into the cabin and, also to the environment. These properties can be ensured if the composite materials have a sandwich structure, made up of different material types with antivibratile and soundproofing features. Taking into consideration the EU Directives, the national legislation in force requests and the usual noise levels of different types of civil work equipment used in Romania [1] [4] [5], the acoustic performances of phonic treatments of the cabins must be characterized by the values from [6] [9].

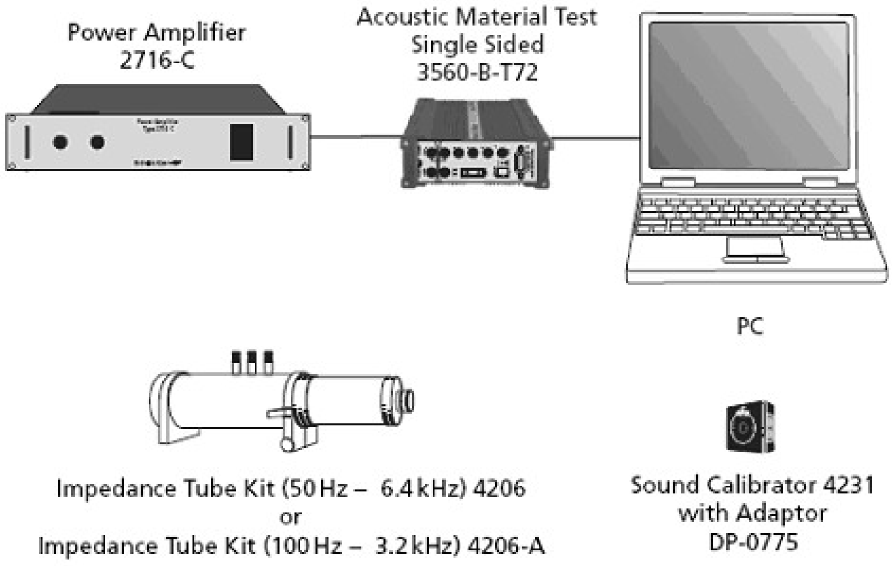


Figure 1 The absorption coefficient $\alpha$ measurements stand - Bruel&Kjaer system

## 2. THE TESTS OF THE COMPOSITE MATERIALS

The laboratory tests data were determined using acoustic standing waves method [2] [3] [7] [8], for 1/3 octave bandwidth. The laboratory experimental test were performed in order to establish:

1) the sound absorption coefficients $\alpha$ for the basis materials, used to manufacture the composite structures; for the basis materials from [6] table 2, the absorption coefficient is between 0.01 to 0.70, depending on the material type and frequency band (figure 1 from [6]);

2) the sound absorption coefficients $\alpha$ for the composite structures, used for the acoustic treatments of the self propelled technological equipment; for the composite structures from [6] Table 3, the variations of the absorption coefficient for a number of sixteen composite structures function of frequency band are shown in Figure 2 from [6].

Figure 1 shows the schematic diagram of the Bruell&Kjaer based system used in case of measurements for the absorption coefficient. The system is mainly composed from a Kundt tube, a power amplifier, an analyzer (PULSE® from Bruël&Kjær is an alternative) and one computer. A sound calibrator can be necessary. The laboratory experimental data were acquired and processed by Bruël&Kjær PULSE Platform type 7758. The values of the acoustic absorption coefficients were determined with Kundt Tube Bruël&Kjær type 4206 for the frequency bandwidth 0÷3200Hz, with an increment pitch of 4Hz [11].

## 3. THE NOISE LEVEL REDUCTION INSIDE THE CABIN OF MMT45. NUMERICAL SIMULATIONS

Figure 2 shows the graphic results of a numerical study of the reduction of the global noise level inside the cabin of the Romanian loader MMT45. The expected values of the noise reduction $\Delta L$ were calculated according to [1] with the sound absorption coefficients of the composite materials measured [5], taking into consideration the following dimensional characteristics and acoustic features of the cabin (sound absorption coefficient - SAC):

- ► $S_1 = 3.8 sqm$ - glass surface area;
- ► $S_2 = 1.7 sqm$ - steel sheet surface area;
- ► $S_3 = 4.7 sqm$ - phonic treated surface area;
- ► $\alpha_1 = 0{,}03$ - glass SAC;
- ► $\alpha_2 = 0{,}08$ - steel sheet SAC (1mm thick.).

## 4. THE NOISE MEASUREMENTS INSIDE THE CABIN OF MMT45

The goal of the project “Modular protective systems from sound absorbent and sound insulation composite materials for civil works equipment” was to establish some protective modular composite structures with soundproofing features intented to be used for the acoustic treatments of the construction technological equipment. The acoustic treatments were used inside the cabin of the Romanian frontal loader MMT45 in order to decrease the global sound intensity level at the driver’s position seat.

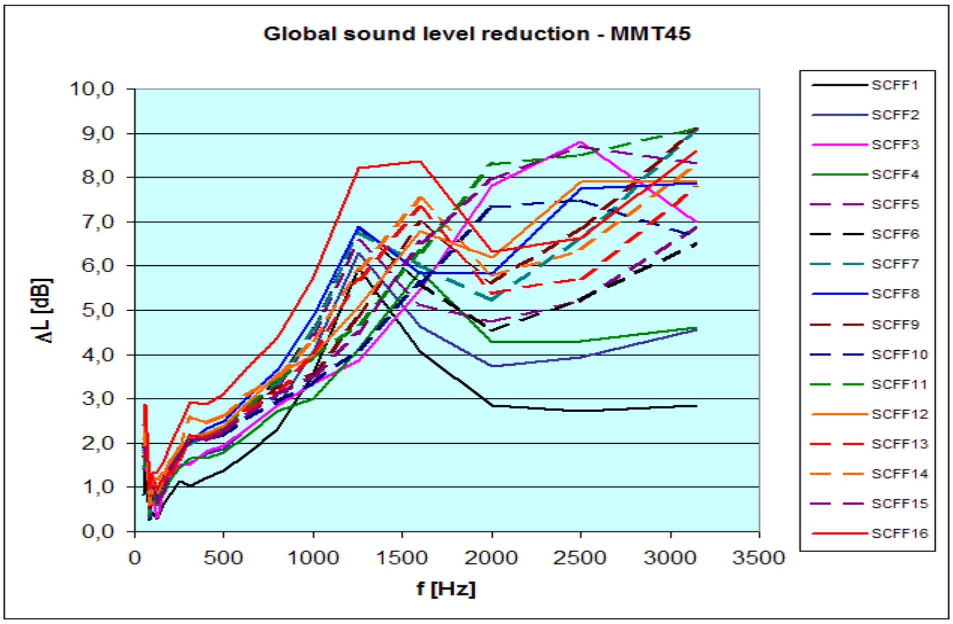


Figure 2 The chart of the global sound level reduction $\Delta L$ inside the cabin of MMT45

Composite structures will be used in the next future for the acoustic treatments of the engine and driving group housings too, in order to decrease the intensity level of the emitted noise into environment.

The experiments were made in site by the specialists of the Acoustic and Vibration Laboratory of the Research Institute for Construction Equipment and Technology Bucharest with the following conditions:

*a) place of measurements:* free acoustic field over a reflective plane;

*b) environmental conditions:* temperature 23÷34$^0$C; air pressure 750÷758 mm Hg; relative humidity 75÷89%;

*c) points of measurements:*

-inside the cabin, in the position of the ear of the driver;

-around the frontal loader, at the 1.20 meter height and 1÷2 meters distance (standardized distances)

*d) time of measurements:* 3÷4 min. (minimum 3 minutes according to standards);

*e) frontal loader MMT45 engine operating mode:*

-running idle (relanti) → 815 rpm

-75% from maximum speed → 1620 rpm

-with the bucket charger down on the ground (no load).

Figure 3 shows an experiment test in order to determine the global sound intensity level inside the cabin of the frontal loader MMT45.

Figure 4 shows the measurement of the noise level emitted in the environment by the engine and the hydraulic pumps of MMT45 (the auxiliary hydraulic pump side).

Figure 5 shows the hand-held analyzer Brüel & Kjær type 2250 used for sound analysis and Figure 6 shows the electronic tachometer T5009 (with accelerometer transducer) used for engine speed measurement.

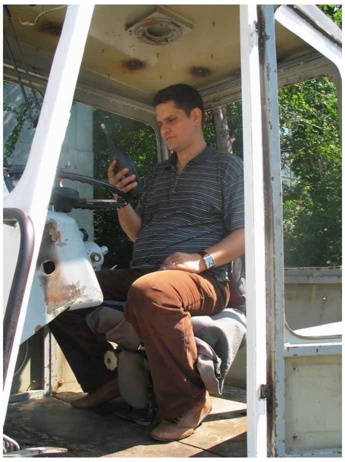

Figure 3 Global sound intensity level measurement inside the cabin of MMT45

Figure 5 Hand-held analyzer Brüel & Kjær 2250 used for noise level measurement

Figure 4 Sound intensity level measurement around the frontal loader MMT45


Figure 6 Electronic tachometer T5009 used for the MMT45 engine speed measurement

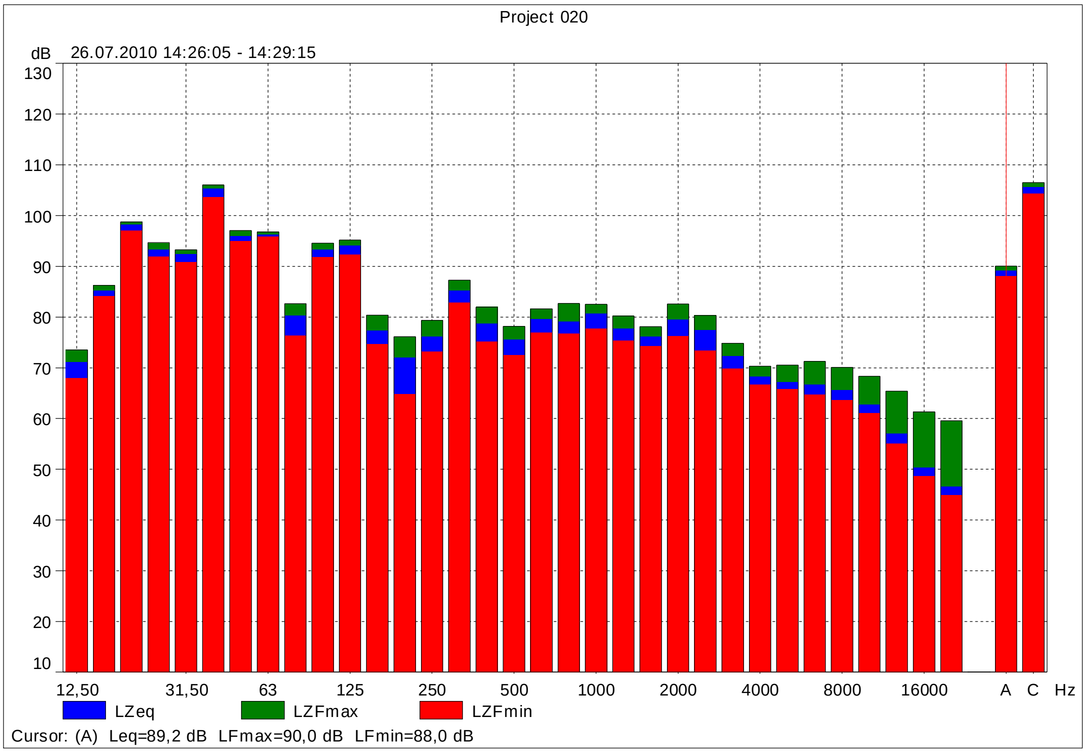


Figure 7 Noise spectrum inside the cabin of MMT45 (no acoustic treatments, 1620 rpm)

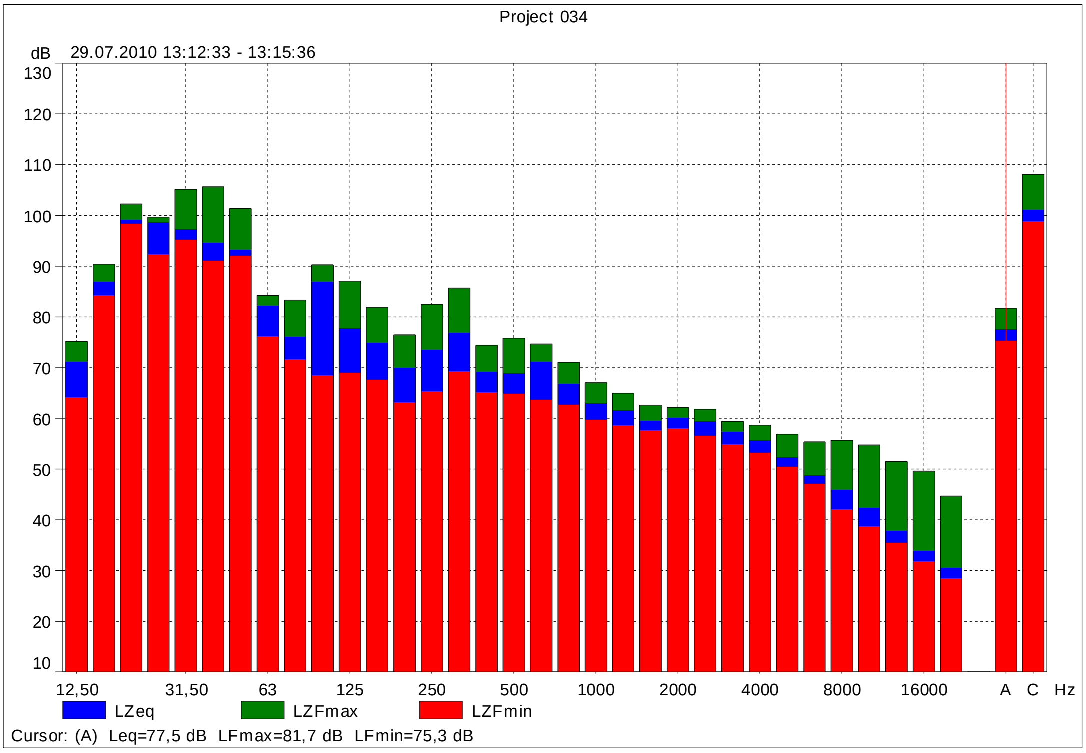


Figure 8 Noise spectrum inside the cabin of MMT45 (with acoustic treatments, 1620 rpm)

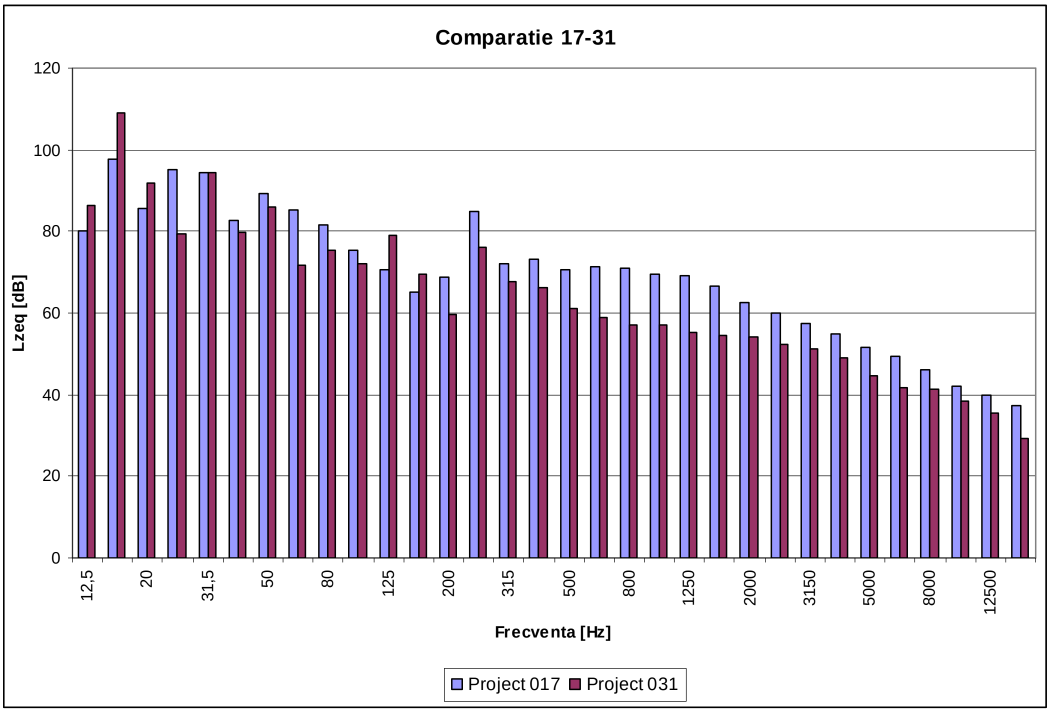


Figure 9 Noise level reduction inside the cabin of MMT45 (815 rpm)

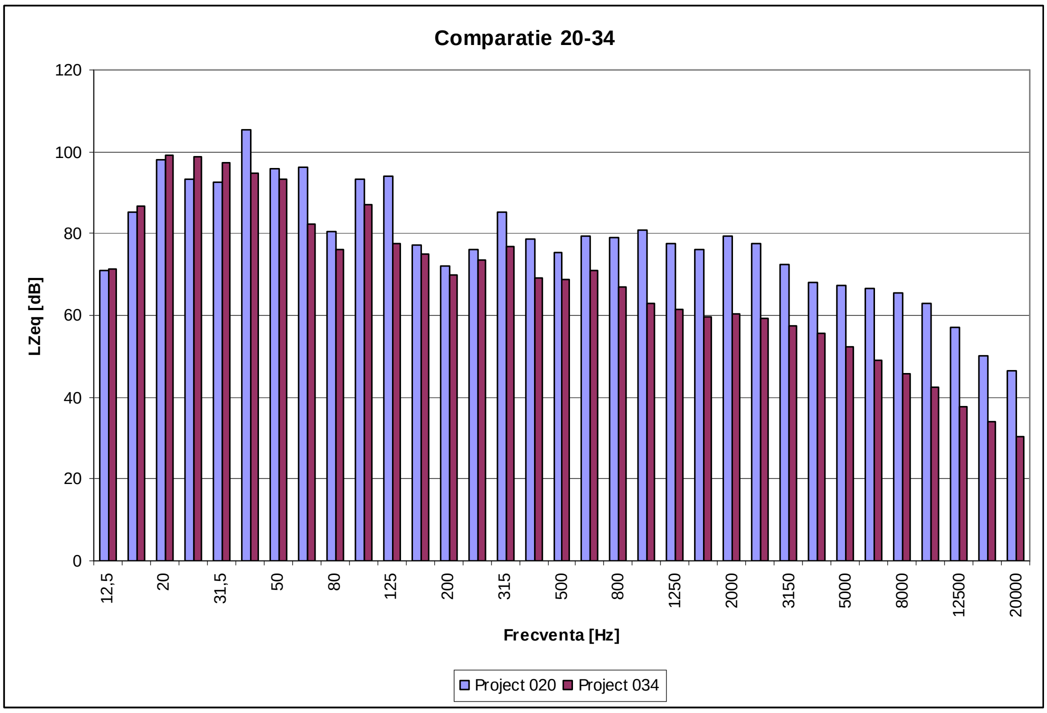


Figure 10 Noise level reduction inside the cabin of MMT45 (1620 rpm)

## 5. CONCLUSION

In order to analyze the noise inside the cabin of the Romanian frontal loader MMT45, we have used the hand-held analyzer Brüel & Kjær type 2250 with prepolarized free-field 1/2″ Microphone type 4189 and microphone preamplifier type ZC-0032. Data acquisition, storage and viewing and frequency analysis were done by the Brüel & Kjær software: “Utility Software for Hand-held Analyzers” type BZ-5503, “Sound Level Meter Software” type BZ-7222, “Frequency Analysis Software” type BZ-7223, “Logging Software” type BZ-7224 and “Noise Explorer” type 7815.

Figure 7 shows the noise spectrum inside the cabin of MMT45 without acoustic treatment, 1620 rpm engine speed, experiment time 3:10 min.. The global noise intensity level is **Leq=89.2dB** and the peak noise intensity level is about 106dB.

Figure 8 shows the noise spectrum inside the cabin of MMT45 after the acoustic treatment application (1620 rpm engine speed, experiment time 3:03 min.). The global noise intensity level is **Leq=77.5dB** and the peak noise intensity level is about 101dB.

Figure 9 shows a comparison between the noise spectra (1/3 octave bandwidth) inside the cabin of MMT45 at 815 rpm, before the acoustic treatment application (blue bars) and after the acoustic treatment application (red bars). It can be seen that, for midlle and high frequency ranges, the sound intensity level has decreased up to 15dB.

Figure 10 shows the comparison of the noise spectra inside the cabin at 1620 rpm engine speed without and with acoustic tratments with composite structures made from PU (PolyUrethane) LD (Low Density) foam based materials. The sound intensity level has decreased up to 20dB function of the noise frequency 1/3 octave bandwidth.

## 6. ACKNOWLEDGEMENT

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