ACOUSTICAL DETERMINATIONS ON A COMPOSITE MATERIALS (EXTRUDED POLYSTYRENE TYPE/ CORK)

Bratu P.[1], Enăchescu G. L.[2], Roşca M.C.,
Vasile O. [1], Iatan R. I. [2]

[1] *I.C.E.C.O.N. Bucharest - icecon@icecon.ro,* [2] *Polytechnica University of Bucharest -*
georgianaenachescu@yahoo.co.uk, r_iatan@yahoo.com

Abstract. *In this article we obtained some experimental results of the extruded polystyreneand and cork. They are absorbtion coefficient, reflection coefficient, impedance ratio. All these are necessary for extracting some properties of extruded polystyrene and cork wich are using in auto industry, plane plates construction etc.*

Keywords: *absorbtion coefficient, reflection coefficient, impedance ratio. impedance ratio*

1. INTRODUCTION

As a result of activities and statistical analysis conducted by the Environmental Protection Agency concluded that there is a continuous upward dynamic noise levels [1]. They are composed of all existing sounds in the monitored traffic coming from either, or at various other facilities in close vicinity. Based on this analysis engineers looking to use appropriate means annihilation or reduction of noise that cause disease population.

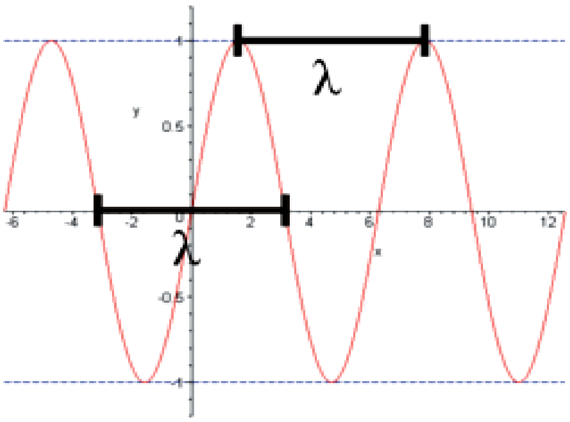


Figure 1. Graphical representation of wavelength λ [3]

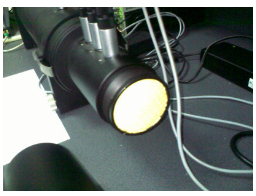


Figure. 2. Reading impedance tube type 4206

This paper covers a study of the sound insulation capacity of the two analyzed materials - expanded polystyrene and cork. Creating a layer of several boards such materials may be one of the " pillars " of reducing the intensity noise base . To reach the final result, first measurements are made on sound absorption coefficient, reflection coefficient and impedance ratio for each card that is found in the layer.

Thus, this paper includes the characteristics mentioned above, for samples of extruded polystyrene and cork. Sound is a mechanical motion of matter. Without matter there is no sound propagation. Sounds arise and propagate not only in gases and fluids, but also in solids. Thus, the oscillation propagates with sonic speed, whose value is characteristic of the propagation medium. Making an analysis of a snapshot of a wave of sonic oscillation in the propagation molecules, it is observed that the oscillation condition is repeated at a definite distance. This distance is called wavelength, λ (Fig. 1). The state of oscillation is repeated over time, the number of oscillations per second is given by the frequency and expressed in hertz (Hz), named after physicist Hertz . Wavelength and frequency are linked by sonic speed: $\lambda = c / f$ [2].

2. THEORETICAL CONSIDERATIONS

The phenomenon in which sound energy surface air encounters a delimitatoare in an enclosed space, which is not reflected, but is (apparently) absorbed by the (sd) is called *sound absorption*. It is characterized by *sound absorption coefficient* α which, in turn, is given by the ratio, subunit between energy (apparently) "absorbed E_a" and the energy incident E_i :

$$\alpha = \frac{E_a}{E_i}. \tag{1}$$

Expression is performed on standardized frequency absorption or classes [4].

Figure. 4. Amplifier

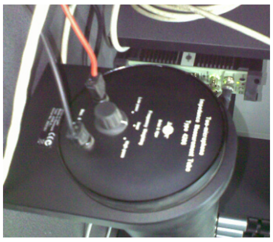
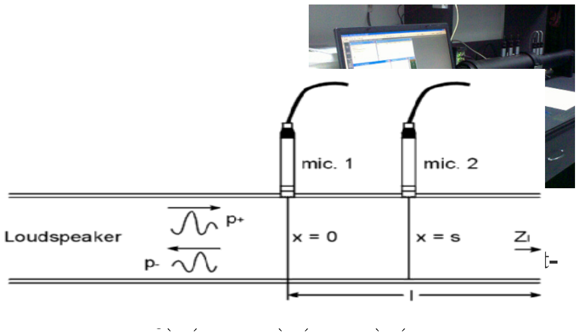


Figure. 3. Transformer



$$p_2(f) = p+(f) \;\; a \;\; e_{-jks} + p\cdot(f) \;\; a \;\; e_{jks}$$

$$R(f) = \frac{p\cdot(f)}{p+(f)}$$

$$R(f) = \frac{H_{12}(f) - e_{-jks}}{e_{jks} - H_{12}(f)}$$

$$\frac{Z_l(f)}{\rho c} = j\frac{H_{12}(f)\sin kl - \sin k(l-s)}{\cos k(l-s) - H_{12}(f)\cos kl}$$

where: p = puls; (f) = frequency; $Z(f)$ = impedance [2].

Fig. 6. Scheme brief reading impedance tube with 2 microphones [7]

Energy conservation law in the separation of the two media is given by:

$$E_i = E_a + E_r, \tag{2}$$

E_r wave energy is reflected in that. Dividing both members of equation (2) with E_i and considering equation (1) we get:

$$\alpha = 1 - \left(\frac{E_r}{E_i}\right). \tag{3}$$

It is known that the energy of a wave is proportional to the square amplitude periodic motion of material point, because:

$$\frac{E_r}{E_i} = \left(\frac{P_r}{P_i}\right)^2. \tag{4}$$

It knows also that the phenomenon of reflection is characterized by the coefficient of reflection or acoustic reflection factor, which is given by the ratio of reflected wave amplitude incident wave amplitude. Sound wave is a pressure wave, the acoustic reflection coefficient relationship can be written:

$$r = \frac{P_r}{P_i}. \tag{5}$$

Substituting into (4), the ratio of reflected pressure wave amplitude, respectively, incident with (5) we get a link between the coefficient of sound absorption and sound reflection coefficient of the form [5]:

$$\alpha = 1 - r^2. \tag{6}$$

Acoustic impedance, denoted as electrical impedance, is equal to the ratio of acoustic pressure and velocity:

$$Z = \frac{p}{v}. \tag{7}$$

Acoustic impedance is measured in the system and Rayl (name given in honor of Lord Rayleigh) or acoustic ohms [1 Rayl (1 Ohm Acoustic) = 1 kg m^{-2}s^{-1}].

Acoustic impedance expression can be written in another form, depending on wave speed and density of the environment ρ :

$$Z = \sqrt{B\rho}, \tag{8}$$

where $B = \rho c^2$, and therefore:

$$Z = \sqrt{\rho^2 c^2} = \rho c. \tag{9}$$

Under well defined conditions of pressure and temperature, the impedance of a medium density ρ_0 is called the characteristic impedance, denoted by Z_0 [6]:

$$Z_0 = \rho_0 c. \tag{10}$$

3. PREREQUISITES EXPERIMENTS

To achieve the purpose of the work, used the following components: reading impedance tube with two microphones, type 4206 (Fig. 2), transformer (Fig. 3), amplifier (Fig. 4), PC data acquisition software Brüel & Kjer (fig. 4) [7].

Reading impedance tube, type 4206, comprises two microphones placed so as to measure sound absorption coefficient, reflection coefficient of acoustic and acoustic impedance ratio in the frequency range 50 Hz ÷ 6.4 kHz [7].

In Figure 6 are given input and output data for determining the absorption coefficient, reflection coefficient and impedance ratio, by reading the impedance tube, type 4206 [7].

In Figure 7 are given the form and appearance of specimens taken from extruded polystyrene and cork (Fig. 8) have been subject to measurement.

Figure 7. Test piece extruded polystyrene

Figure 8. Test piece of cork

4. EXPERIMENTS - SETTINGS PRIOR DETERMINATION OF MATERIAL CHARACTERISTICS

Figures 9 - 14 are presented in succession, the settings that were used during the reading of experimental results.

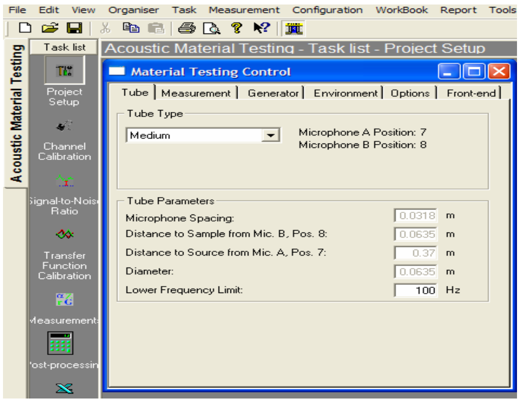


Figure 9. Selecting the type and parameters for determining the impedance tube

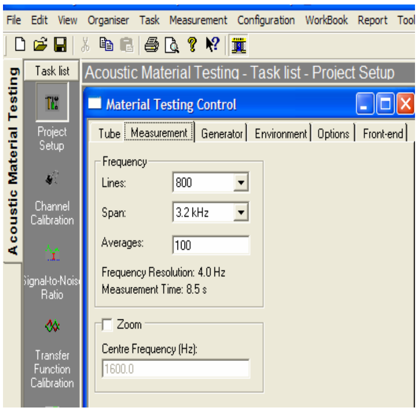


Figure 10. Measurement parameters: frequency, frequency resolution and measurement time

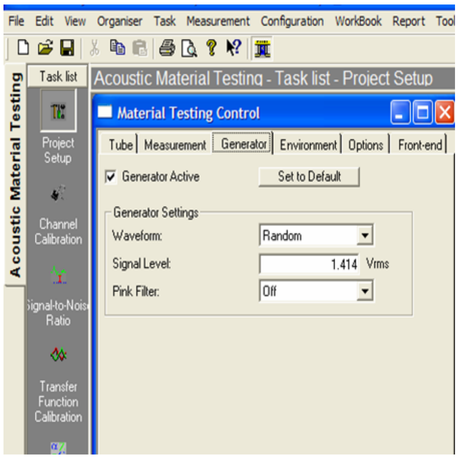


Figure 11. Generation settings: noise and signal waveform

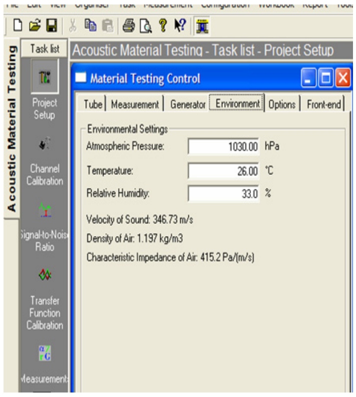


Figure 12. View the settings for the environment: pressure, temperature, relative humidity, speed of sound, air density and characteristic impedance of air

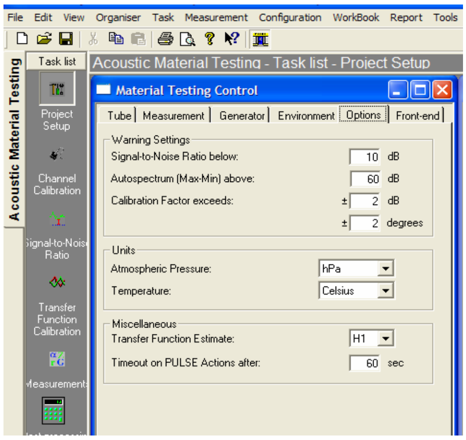


Figure 13. Alert settings, units and during the drive pulse

4. 1. EXPERIMENTAL RESULTS

Characteristic measurements were made for the two materials above.

4. 1. 1. Extruded polystyrene

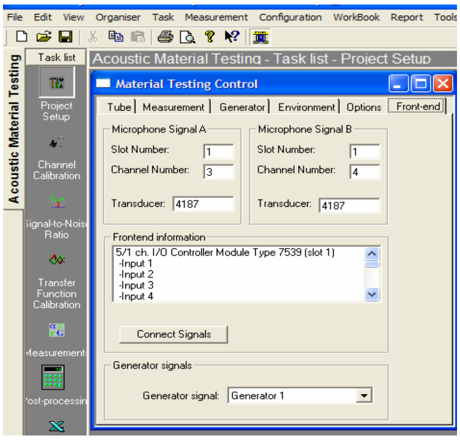


Figure 14. Signals of both microphones and signal generator

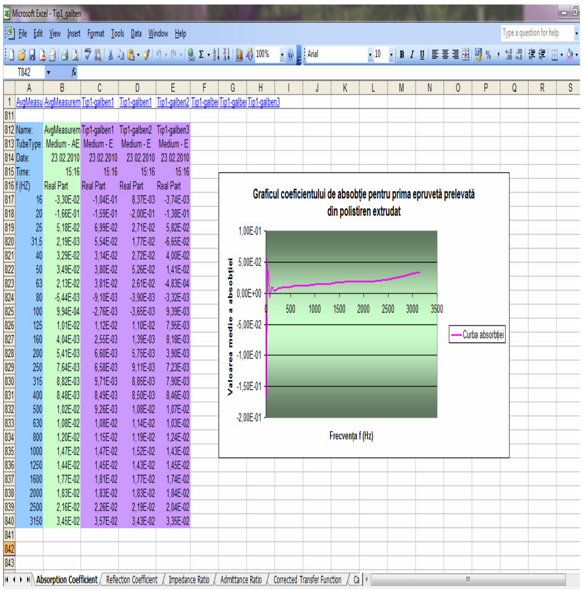


Figure. 15. The results for the average sound absorption for the first specimen taken from AE extruded polystyrene

According to data sheet for plates of extruded polystyrene, which were taken specimens that acoustic measurements are made, they have a uniform structure of closed cells, which confers certain specific technical features, such as low conductivity value heat, long term, excellent mechanical strength, lack of capillary, high moisture resistance, resistance to freeze-thaw cycles, high durability, high resistance to vapor diffusion, low density and ease of handling, easy to cut with simple tools, strength deterioration under the action of roots (for underground placement).

Interpreting acoustic absorption curve - Fig. 15, we can draw the following conclusion: when the speaker switched during the first phase penetration of sound waves, which restored the negative values up to - 1.66 E-01, then a sharp increase followed by a decrease until reaching a state of continuous growth, the average absorption rate increases with raising. This finding may support the hypothesis that sound-absorbing material is extruded polystyrene.

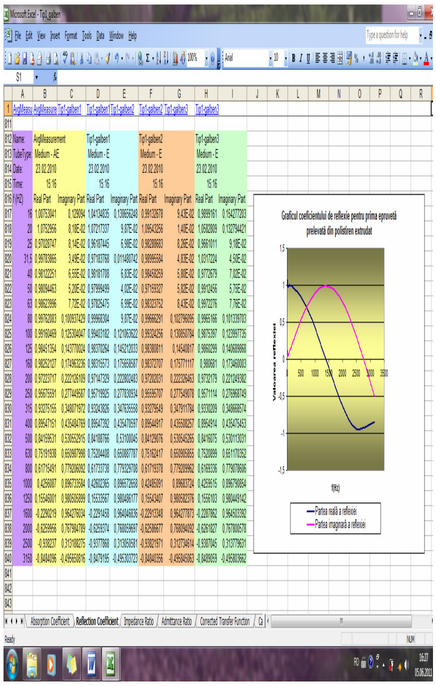


Fig. 16. Acoustic reflection coefficient chart for the first specimen taken from the extruded polystyrene

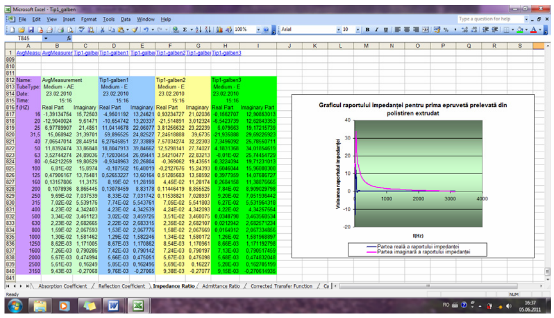


Figure 17. AE medium impedance ratio for the first specimen taken from the extruded polystyrene

Comparing the two curves of the coefficient of reflection - fig. 16 - see that was a reflection of the first real value to 1.00753041, at a frequency of 16 Hz, while the imaginary value of 0.129094 occurred at the same frequency, which makes us specimen is taken to say that the reflection coefficient, increased. Partial return of sounds in the environment in which the specimen came to the meeting area, initially due to high reflection coefficient just this, then the behavior of real reflection coefficient is in a similar shape, the imaginary.

From equation (1), we see that the minimum ratio is lower than if the imaginary real, when training curve, as of 1030 kPa pressure, which means that there has been an increase in acoustic velocity. This was due to disturbance intensity transformer DC recorded during experimental measurements. An increase in the number of oscillations per second occurs near the two curves, as much to confuse, which means that the report reaches the desired impedance and thus extruded material is a good receiver sound pressure.

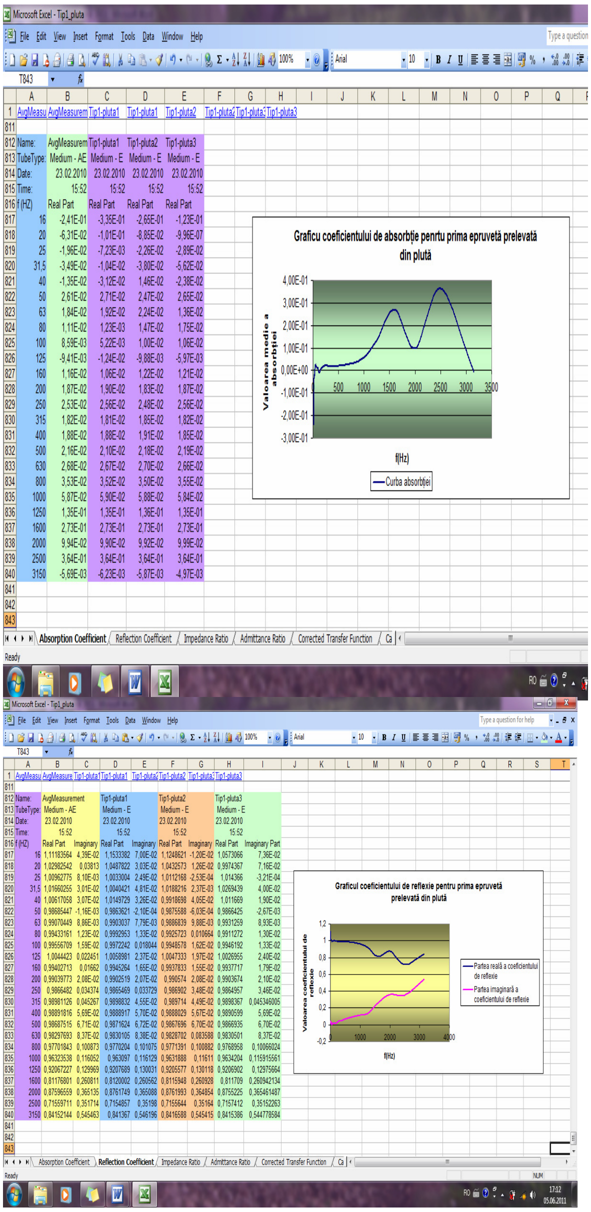


Figure 19. Acoustic reflection coefficient and graphs to the average for the first specimen taken from the cork

4. 1. 2. Cork

We know that cork is the bark of cork oak and has a number of characteristics (low density, elasticity convenient, waterproof, low conductivity, good resistance to wear), which makes it increasingly used in various industrial purposes and not only [8]. For a specimen taken from the cork were performed acoustic measurements of properties as for polystyrene materials [7] and extruded polystyrene. Absorption coefficient of the graph you can see the texture of sound penetration specimen during increasing frequency from 16-40 Hz oscillations that occur after the lower curve of absorption, followed by a continuous increase, followed by a regression, in the negative, this state shows that there is a sound energy absorption, but not as good as in the range of frequencies from 500 Hz to 1500 Hz. This phase of growth followed by decline, repeated as the frequency is higher.

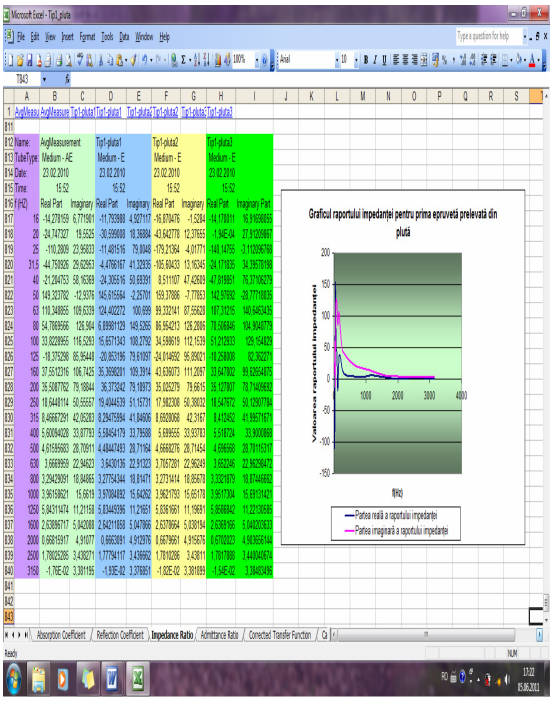


Figure 20. AE medium impedance ratio for the first specimen taken from the cork

After the value of 3100 Hz frequency, the absorption curve is found as in the initial phase, which shows that the specimen thickness (3mm) can not absorb sound energy by 3150 Hz. Comparing the graphs in Figures 3…18 p.m. we can see that in both cases the first phase sounds can penetrate into fabric, then absorption occurs in a proportion lower or higher.

In Figure 19 we can see that the reflection coefficient curve for the real and imaginary part to have an approximately similar shape and is ending upward curve, which shows that the partial return of the original sounds in the environment is possible.

As with extruded polystyrene impedance ratio in the real comes to be confused with that of the imaginary, which is desirable - Figure 20.

5. CONCLUSIONS

This paper addresses research absorbing characteristics of extruded polystyrene and cork, through experimental tests on three samples of each material. Since experimental results are close both in terms of forms of variation in sound frequency, and value in the article are exposed only to the first sample diagrams.

Should be noted that restricting the time of testing equipment, in terms of thickness specimens, at present cannot give values on the absorption of sound energy in the case of laminated plates. This can be done properly, the carrier further research, properly equipped premises in structure and scope of testing.

6. REFERENCES

[1] Arghir, M, S. A., monitoring road traffic noise, Didactic and Pedagogical Publishing House, Bucharest, 2008

[2] Anghel, V., Acoustic (course)

[3]http://ro.wikipedia.org/wiki/Lungime_de_und%C4%83

[4]http://www.ursa.ro/_files/normativ_privind_protectia_la_zgomot.pdf

[5]http://newton.phys.uaic.ro/data/pdf/INTERFER.pdf -reflection and absorption

6]http://www.scritube.com/biologie/biofizica/UNDE-ACUSTICE - I - UNDE SONORE 242182022.

[7] Bratu, P., ed. A., Acoustical Determinations on a Composite Material Type Expanded Polystirene, The 9th International Conference, OPROTEH 2011, Bacau, May 24-26, 2011

[8] http://www.produsepluta.ro/articol/ro/pluta-12/ce-este-pluta--31