ACOUSTIC PROPERTIES OF CELLULOSE

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Abstract: Cellulose is the oldest material for thermal insulation in construction field. Thomas Jefferson was the first architect that used the cellulose in his project of the Monticello house (1800). But only after 1945 that the cellulose from newsprint was used across America and northern Europe. In the 70s with the energy crisis in Austria, Czech Republic, Switzerland and Germany began the production of cellulose derived from paper newspapers. It used for both winter and summer thermal insulation, while respecting the environment. In this paper are reported acoustic measurements carried out with the tube of Kundt, with the cellulose melted and with glue with different thicknesses.

Keywords: Cellulose, impedance tube, absorbent coefficient.

1. INTRODUCTION

Among the fibers, cellulose is the most representative biopolymer and it is widely used for producing paper and cardboard. Cellulose is the oldest material for thermal insulation in construction field. Thomas Jefferson was the first architect that used the cellulose in his project of the Monticello house (1800). But only after 1945 that the cellulose from newsprint was used across America and northern Europe. In the 70s with the energy crisis in Austria, Czech Republic, Switzerland and Germany began the production of cellulose derived from paper newspapers. The cellulose is used for both winter and summer thermal insulation, while respecting the environment. This material has good thermal insulators, not harmful to human health, recyclable, renewable, widely available and low cost and it is an alternative to the synthetic fibers in different applications, also in the acoustic field.

2. THE CELLULOSE

The cellulose manufacturing process is as follows. The selected paper is subjected to various grinding processes and defibration. The defibering process is carried out with pneumatic machines, this to allow the aspiration and the removal of unwanted dust particles. At the end of the additives are added fireproof and fungicides. This processing method is performed delicately, to maintain the typical elasticity of the cellulose. The visible property of each individual staple is similar to that of a cotton swab. Thanks to this characteristic the flakes create a perfect bond between them, as if they had many small claws that cling to one another, in a three-dimensional grid. During installation, this feature is important because it ensures the perfect sealing of the material. The finished product is packed in bags of polyethylene, to ensure
excellent protection. The cellulose is made from recycled materials; it does not use polluting substances during the production. Furthermore it is a biodegradable product, easily reaches cavity and places difficult to isolate. It maintains its thermal resistance value with a wide range of density and temperature.

3. SOUND ABSORPTION COEFFICIENT MEASUREMENTS

Sound absorption coefficient at normal incidence was determined according to procedure described in ISO 10534-2 [1, 2, 3]. This method allows to measure acoustic parameters by using small samples that are easy to assemble and disassemble. Measurements were carried out using the tube of Kundt (impedance tube), with the following features: internal diameter of 10 cm (corresponding to a lower limit of 200 Hz, an upper frequency limit of 2,000 Hz), a length of 56 cm and mounts two ¼” microphones. The tube of Kundt is composed of a speaker located at one end of the tube, from which is emitted a pink noise. While to the opposite side is placed a termination in which is housed the trial material, on a rigid wall with a circular section of a diameter of 100 mm [4, 5, 6]. The absorption coefficient is obtained from the combination of the transfer functions measured in the two measuring microphones, placed inside the tube; the distance from the two measurement microphones is 5.0 cm. To limit effects due to irregularities in samples, for each sample four different measurements were performed, every time stirring and inserting the material in the tube [7, 8, 9]. Resulting absorption coefficient values are the average of four acquisitions [10]. Fig. 1 shows tube of Kundt (or impedance tube) for normal sound absorption coefficient measurement.

Fig. 1. Tube of Kundt for the sound absorption coefficient measurements.

4. MATERIALS

The materials used for the acoustic measurements are different types. The first type of material used is the melted cellulose; this material is produced directly from the processing of the recycled newspapers. The material is melted and very compact. Fig. 2 shows the material in use. The Fig. 3 shows for two different thickness (5 cm and 10 cm) the values of absorbent
coefficient measured with the impedance tube. The values of absorbent coefficient is very height especially over the frequency of 500 Hz. At the frequencies lower than 500 Hz, the material loses some the capacity to absorb sound, this problem is typical of porous materials. Even if the thickness is doubled (from 5 cm to 10 cm) the value of the absorption coefficient at low frequencies is always low. Furthermore the problem of the use this material that it is melted. So the material to be used must be inserted in the acoustically transparent bags [11, 12]. Another possibility is to mix the loose material with glue and get a rigid material for use for absorb sound. Fig. 4. shows rigid material obtained by loose material with glue. In this way, the material has a rigid skeleton, so it can be employed with greater simplicity. Fig. 5 shows the material specimens with rigid skeleton used for the acoustic measurements. The Fig. 6 shows for two different thickness (5 cm and 10 cm) the values of absorbent coefficient measured with the impedance tube of the material with rigid skeleton. As the expected the values of the absorption coefficient with the rigid skeleton structure are reduced. But in any case they are greater than 0.6 for the thickness of 5 cm and greater than 0.7 for the thickness of 10 cm.
Fig. 4. Rigid material obtained by loose material with glue

Fig. 5. Specimens with rigid skeleton used for the acoustic measurements.

Fig. 6. Absorbent coefficient of the rigid skeleton cellulose.
5. CONCLUSION

In the present paper are shown acoustic measurements of the absorption coefficient of the cellulose when it is loose and when it is mixed with the glue with a structure with skeleton rigid. Into both cases the cellulose is taken as a good system for absorb sound in a simple, economic and environmentally compatible way. Furthermore this material is a good thermal insulators, not harmful to human health, recyclable, renewable, widely available and low cost and it is an alternative to the synthetic fibers in different applications.

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