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INVESTIGATION OF DAMPING PROPERTIES USING PRODUCTS COMING FROM ELT (END-OF-LIFE-TIRES)

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Abstract: Nowadays, noise and vibration pollution is a problem to solve. The noise and vibrations increase in developing and developed societies, and especially in the latter an even more demanding legislation to control noise, both inside and outside of residential areas, is being generated. Moreover, the recycling of products from the ELTs (End of life tires) is a pending issue, particularly in developing countries.

1. INTRODUCTION

Nowadays, noise and vibration pollution is a problem to solve. The noise and vibrations increase in developing and developed societies, and especially in the latter an even more demanding legislation to control noise, both inside and outside of residential areas, is being generated. Moreover, the recycling of products from the ELTs (End of life tires) is a pending issue, particularly in developing countries [1-5]. Thus, the use of this type of waste, for obtaining a vibration absorbent, could solve two environmental problems, vibration and environmental pollution. The raw material used is the residue coming from the shredding of tires for heavy vehicles. This product is composed of elastomeric nature waste named; GTR (Ground Tire Rubber); loose and adhering to the fibers, textile fibers and metal fibers (steel) [6-7]. The textile fibers obtained is named fluff.

2. EXPERIMENTAL

2.1. MATERIALS

We have made samples by sintering with GTR and GTR tire with recycled fibers (fluff), with different particle sizes and different percentages of fiber. The Table 1 shows the composition of used material and the grain size of GTR. The fiber used are of two kinds; microfiber and fiber, each one having different length. Microfiber has the small, having a mean length of 2mm, and fiber having a mean length of 20mm.

TABLE 1. Grain size of GTR and fiber percentages.

		Fluff (%)	
Material	**Grain-size (mm)**	**microfiber**	**fiber**
Mat 1	2		5
Mat 2	2	5	
Mat 3	2		25
Mat 4	5	5	
Mat 5	5		5
Mat 6	5		25
Mat 7	0,2		
Mat 8	0,2		

2.2. CHARACTERIZATION

To determine the loss factor in some rubber wasted materials, the “Standard ASTM E-756-05: Standard Test Method for Measuring Vibration-Damping Properties of Materials” is followed [8].

Eight specimens have been tested. Table 2 shows the characteristics of these materials.

Table 2. Density and Thickness of each material.

Material	Density (kg/m^3)	Thickness (mm)
Mat 1	983.33	10
Mat 2	1049.38	9
Mat 3	1080.35	11
Mat 4	931.37	11
Mat 5	766.37	13
Mat 6	1007.59	12
Mat 7	1058.2	9
Mat 8	1017.11	10

The process to obtain the damping properties of non-self-supporting damping materials requires a sandwich specimen configuration to be tested. Figure 1 show the scheme used to prepare the sandwiched specimens.

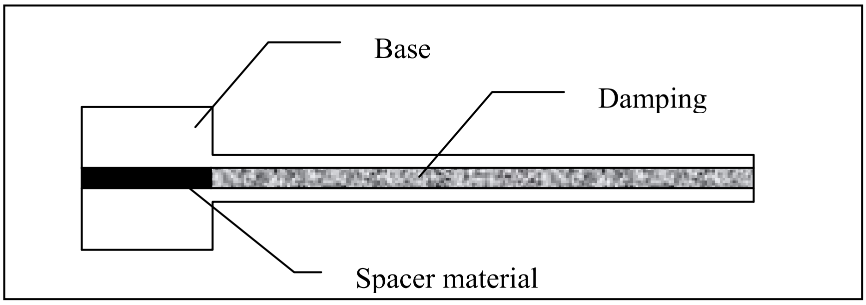

Figure 1. Scheme followed for sandwiched specimens.

Figure 2 shows the scheme of the experimental set used for measuring the loss factor, and a picture of the system.

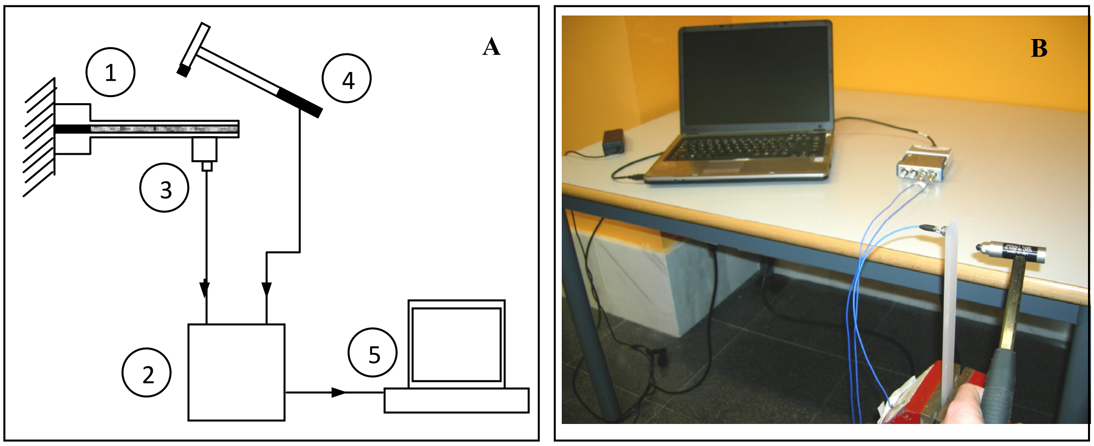

Figure 2. A) Scheme of the experimental set: 1. Composite beam; 2. Data acquisition card; 3. Accelerometer; 4. Impact hammer; 5. Computer. B) Picture of the system used for measuring the loss factor.

Then, using the equations in the Standard, the loss factor is determined (eq. 1):

$$\eta_1 = \frac{(A\eta_s)}{[A - B - 2(A - B)^2 - 2(A\eta_s)^2]}$$

η_1 = shear loss factor of damping material, dimensionless,
$\eta_s = \Delta f_s / f_s$, loss factor of sandwiched specimen, dimensionless,
A = $(f_s/f_n)^2(2 + DT)(B/2)$,
B = $1/[6(1+T)^2]$,
D = ρ_1/ρ, density ratio,
ρ_1 = density of damping material, kg/m^3,
ρ = density of base beam, kg/m^3,
f_n = resonance frequency for mode n of base beam, Hz,
f_s = resonance frequency for mode s of composite beam, Hz,
Δf_s = half-power bandwidth of mode s of composite beam, Hz,
T = H_1/H, thickness ratio,
H, thickness of base beam, m,
H_1, thickness of damping material, m,

3. RESULTS AND DISCUSION
3.1. RESULTS

The output signal is processed with a Matlab function. The following graph shows the frequency response function, and the peak of the second mode of each material (Figure 3).

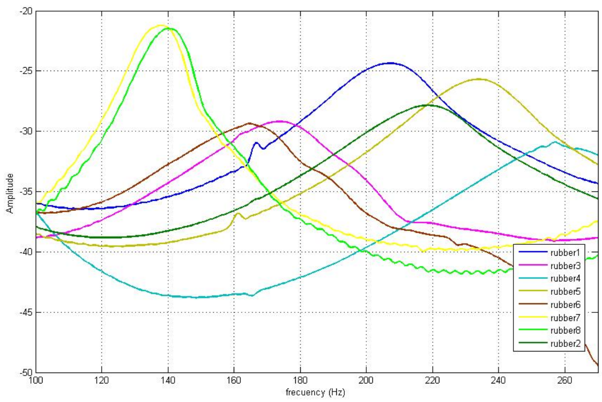

Figure 3. Frequency responses function of each material.

Table 3 shows the loss factor of each material.

Table 3. Loss factor of each material.

Material	Density (kg/m^3)	Thickness (mm)	2º Mode (Hz)	(Loss Factor)
Mat 1	983.33	10	209	0.585
Mat 2	1049.38	9	221	0.574
Mat 3	1080.35	11	177.5	0.823
Mat 4	931.37	11	257.5	0.414
Mat 5	766.37	13	235	0.194
Mat 6	1007.59	12	166.5	0.409
Mat 7	1058.2	9	138.5	0.264
Mat 8	1017.11	10	141.5	0.232

3.2. DISCUSSION

The results show that the loss factor is greater when using fine grain, while the increase of fiber causes an increase of the loss factor in both the fine-grained samples as in coarse-grained samples. The result is consistent with the mechanical properties obtained in the sintered products of GTR, where the finest grain sizes have better elastomeric properties, increasing the tensile strength and elongation, resulting in lower modulus of elasticity [9]. A more elastomeric material has in the internal structure mechanisms of energy absorption that justify their anelastic behavior. The increase in loss factor with the percentage of fibers show that there is an interaction between the fiber and GTR; this fact applies to both grain sizes. On the other hand the increase in loss factor caused by the fiber is very intense when comparing the values with those obtained for products without added fiber. The presence of the fiber suppose an increasing internal mechanisms for energy absorption, the fiber acting as an area of energy dissipation through an interface effect, the neighboring areas of elastomer near the fibers dissipate more energy than the areas not so close. The cause could be due to the presence of an interface between two materials of different rigidity, where shear tensions are developed, which fluctuation in the vibrational process, cause more intensive mechanisms of energy absorption.

4. CONCLUSIONS

The values obtained for the loss factor show that the material obtained by sintering of GTR and fluff is suitable for application in vibration absorption processes. During this research process we are developing new samples with constant thickness and higher fiber percentages. On the other hand we are now analysing samples of constant mass.

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