EXPERIMENTAL PROCESS FOR DETERMINING THE DAMPING PROPERTIES OF BARS WITH AROPOL MATRIX

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Abstract. In this paper, I have built a composite sample made from glass fiber as reinforcement and Aropol as matrix. For this sample, I have used an experimental procedure to determine the damping properties and the frequency of the first eigenmode. The experimental process is characterized by clamping the bar at one end and leaving it free at the other. At the free end, I have placed an accelerometer to record the bar free vibrations. I have applied an initial force, then I have removed the force and left the sample to vibrate without any other restrictions. From these vibrations I have determined the damping factor and the eigenfrequency.

Keywords: aropol, composite bar, damping properties, eigenfrequency

1. INTRODUCTION

Aropol resins are usually used in manufacturing processes like: open mold laminating, bulk molding compound, resin transfer molding, pultrusion, infusion and so on [1]. This resin also provides high mechanical and impact properties and good surface profiling [1]. Other features presented by this resin can be: excellent physical properties, high elongation, good pigment compatibility, and so on [2]. For Aropol XO tooling resin, the mechanical properties at 23^0C are: viscosity Bookfield RV3 2300 mPas, viscosity cone & plate 330 mPas, monomer content 30%, exothermal peak at 90^0C, density 1.37 g/cm^3 [3].

Mechanical properties for other Aropol resin types can be found in [4]. In order to obtain good mechanical properties for a composite sample, usually, as reinforcement for Aropol resins can be used fiber glasses, carbon fibers, Kevlar fibers or carbon-kevlar fibers. Because of its low cost, the fiber glass is the most used in combination with Aropol. This type of composites can be also used for repairing objects, like pipe sections [5].

According to the composite literature, in order to determine the damping properties for a sample, the next experimental process can be used: the bar can be clamped a one end and the other can be left free. Then, at the free end an accelerometer can be placed in order to record the sample free vibrations. The accelerometer is usually connected directly to a data acquisition system or to a signal conditioner that is connected to a data acquisition system. In order to obtain the experimental results, the data acquisition system is connected to a notebook (usually through USB or LAN ports).

Then, an initial force can be applied to the sample and deform it. Then, the force is removed and the sample is left to freely vibrate. With the accelerometer there can be recorded the free vibrations. From the free vibrations data, the damping factor and eigenfrequency can be determined. This type of experimental process was studied before in [6], [7] or [8] where good results have been obtained.

2. SAMPLE PRESENTATION

The studied sample in this paper is presented in fig. 1.

Fig. 1. The studied sample

The experimental scheme is presented in fig. 2, where I have written that the free length of the bar will vary between 100 and 240 mm, with a distance of 20 mm between the gaps. I have chosen several free lengths values because I want to study the damping factor variation versus the bars length.

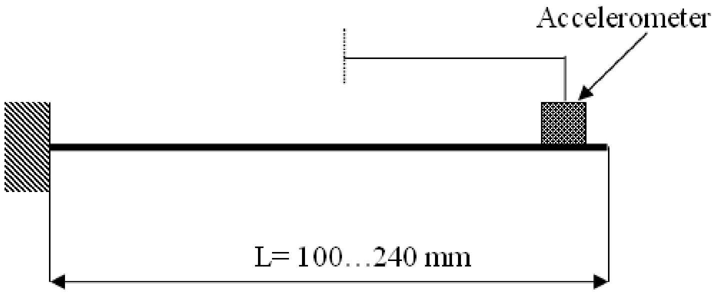

Fig. 2. The experimental montage scheme

3. EXPERIMENTAL RESULTS

In fig. 3 I have presented the experimental recordings for the studied sample, with the free length of 100 mm. For the same free length, I have made twice the recordings in order to avoid high errors that can appear from the experimental process (for example the sample may not be clamped very well at the end and may move during the initial force application, which will surely insert errors during the damping factor and eigenfrequency processing). In fig. 4 and 5, I have presented the damping factor and eigenfrequency calculus. The damping factor and eigenfrequency calculus was made according to the methodology presented in [6], [7] or [8]. The results show that small differences are obtained for the damping factor and eigenfrequency. The final damping factor and eigenfrequency results were obtained by making the arithmetic mean of the values (with approximation of 3 decimals): damping factor = 0.747 (Ns/m)/kg; eigenfrequency= $5.521 s^{-1}$. For the rest of the lengths, the results are written in table 1.

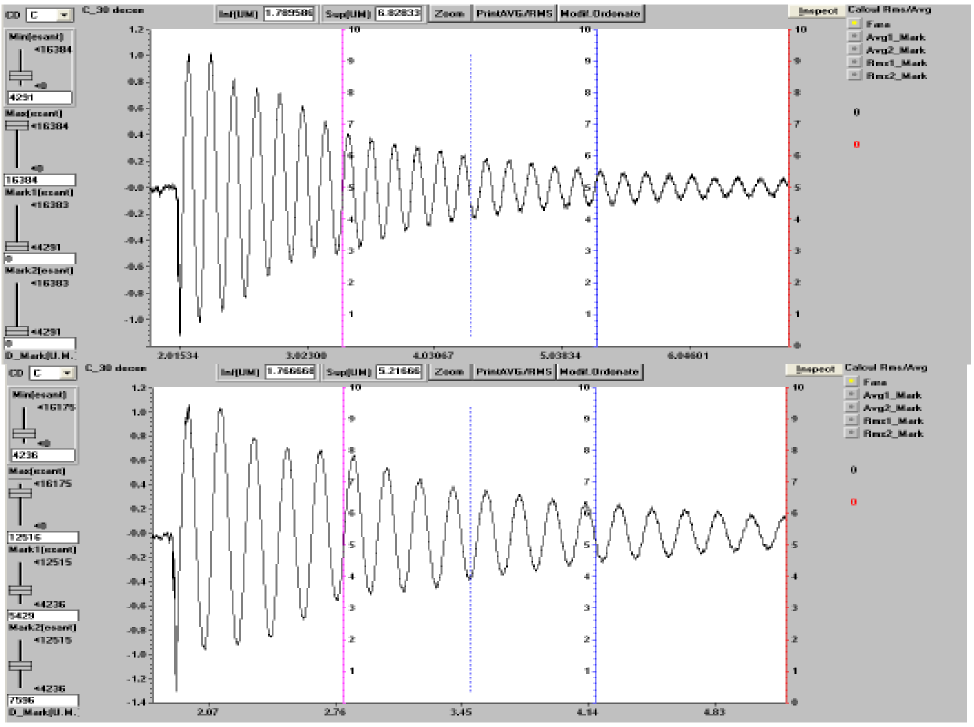

Fig. 3. The two experimental recordings for the 100 mm sample free length

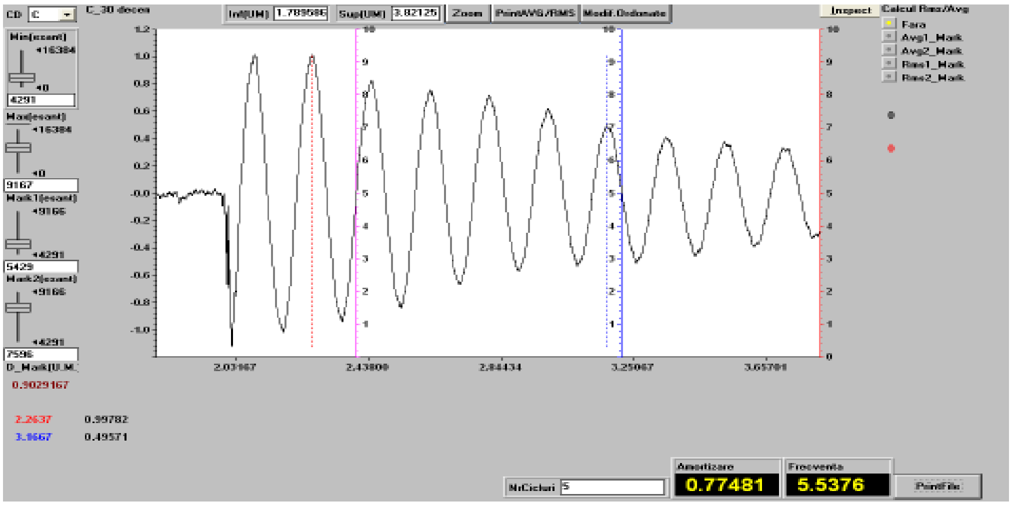

Fig. 4. Damping factor and the frequency of the first eigenmode calculus for the samples with 100 mm free length, first recording

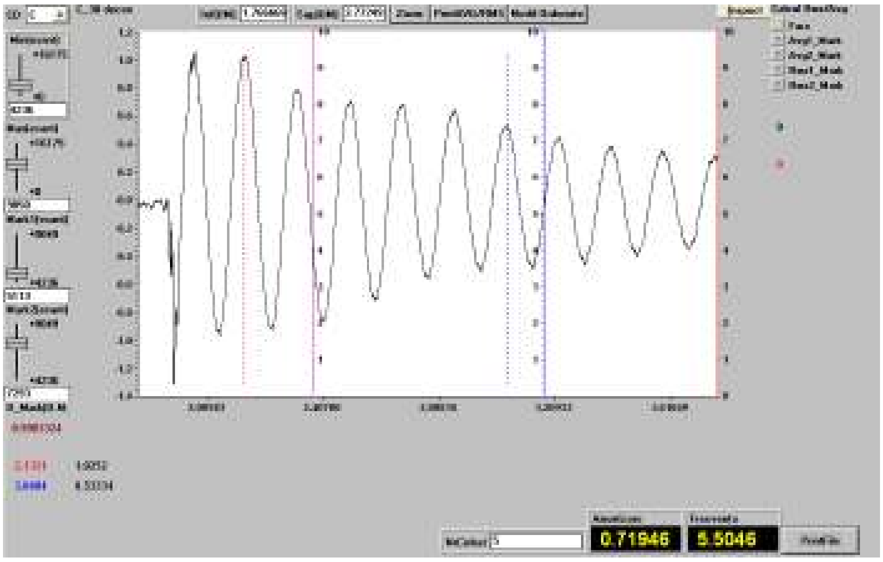

Fig. 5. Damping factor and the frequency of the first eigenmode calculus for the samples with 100 mm free length, second recording

Table 1. The damping factor and eigenfrequency experimental results

Free length [mm]	Damping factor [(Ns/m)/kg]	Eigenfrequency [1/s]
100	0.747	5.521
120	0.519	3.834
140	0.381	2.817
160	0.292	2.157
180	0.213	1.704
200	0.187	1.38
220	0.154	1.141
240	0.13	0.959

The damping factor and eigenfrequency variations with the bars free length are presented in fig. 6 and 7.

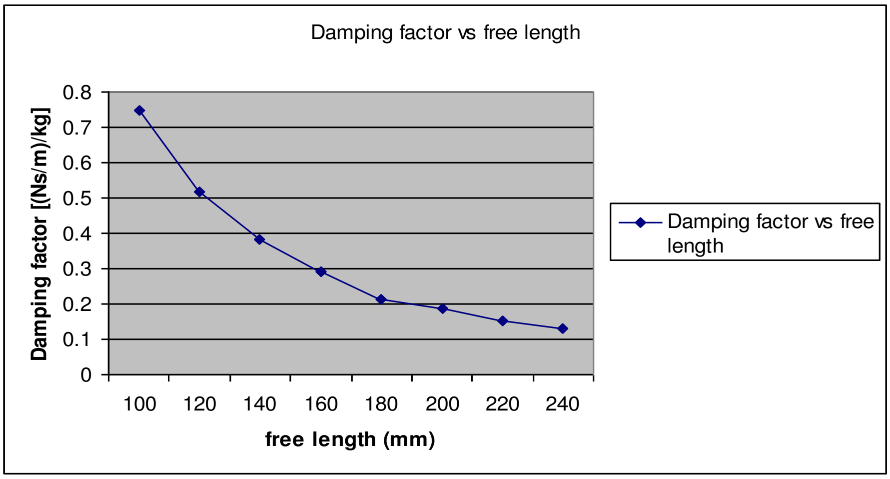

Fig. 6. The damping factor versus the sample free length

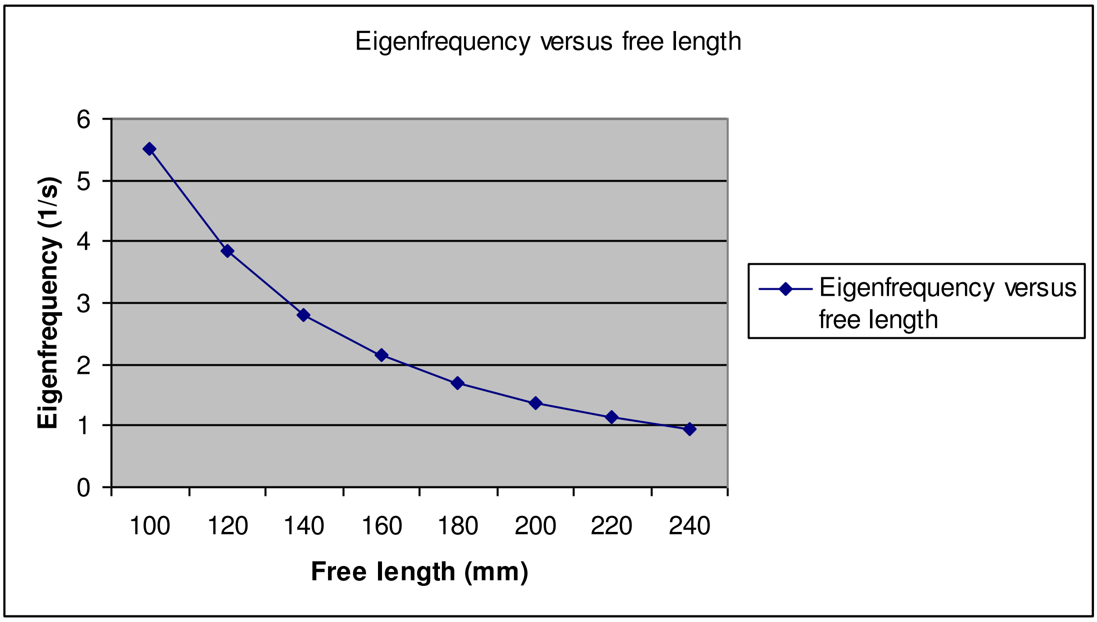

Fig. 7. The eigenfrequency versus bars free length

4. CONCLUSIONS

In this paper I have made a composite material by mixing the Aropol resin with fiber glass. For this sample I have determined some mechanical parameters that characterize its vibration behaviour:

- the damping factor;
- the eigenfrequency.

The experimental setup was characterized by clamping the bars at one end and leaving the other free, where an accelerometer was placed to record the sample free vibrations. As a general conclusion, from fig. 6 and 7 I can see that both damping factor and eigenfrequency decrease with the increase of the sample free length.

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