# Evaluation of Vibration Damping in Composite Sandwich

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*The purpose of this paper is to study the performance of composite and structures materials (laminates composites reinforced with carbon fiber and sandwich materials with laminated composite faces and foam core) by theoretical and experimental analysis on damping capacity vibration. Experiments were carried to determine the elastic and damping characteristics of composite materials on a small-scale configuration of a machine tool structure having the purpose of knowing the damping vibration ability of a column position on a Polypad structure.*

*Keywords: composite, sandwich materials, vibration damping, spindle, frequencies*

Damping structural components and materials is often overlooked in designing. The lack of damping in structural components lead to catastrofal mechanical damages. Many research was done to supress vibrations and reduce mechanical failures. Interest on vibration attenuation is of major importance, especially in applications characterized by dynamic loads, since vibration amplitudes are directly related to fatigue resulting in damage to the structural integrity [1]. The possibility to control vibration and noise, in a dynamic system, has been exploited by many researchers. Currently, among the different methods to enhance damping behaviour of composite elements or structures, three main categories are recognised, according to the specific mechanisms of dissipation energy, namely: active, semi-active and passive methods [2]. Polymeric materials are widely used in damping noise and vibration. Composite materials reinforced with fibers exhibit damping characteristics associated with viscoelastic behavior of polymeric matrices [3]. One of the important properties of these materials, in addition to high damping capacity, is the large variation in frequency dynamic properties [4-7].

Investigated material is a composite material produced by Texmer (Germany) and has the trade name POLYPAD. It is sold in two dimensions on the market: thickness 9mm and thickness 18mm (fig.1).

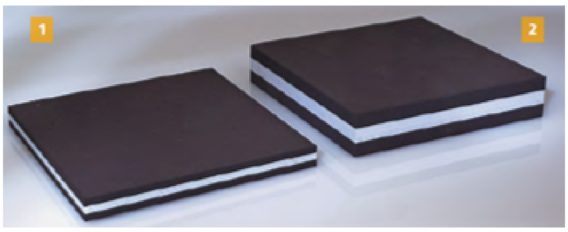


Fig. 1. Picture of the composit material POLYPAD experimentally investigated

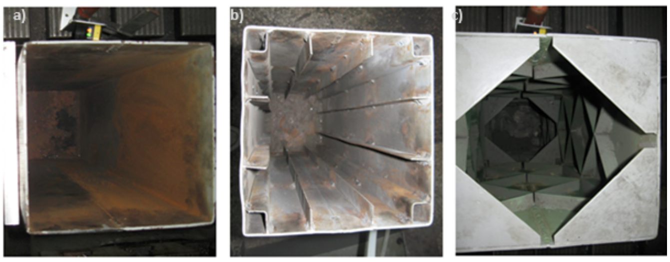

Fig. 2. a) Column without stiffeners, b) column with longitudinal stiffeners c) column with complex stiffeners.

According to the manufacturer's recommendations, POLYPAD composite material is used for industrial machines as vibration damper (because it allows mechanical shocks absorption). Also, it ensure stability of equipment that are placed upon it (having antifriction properties) and is resistant in contact with oils and acids used in industry.

It is known that composite materials associated with the elastic behavior of polymeric materials present damping characteristics. In applications in which dynamic loads are involved, the interest in achieving vibration attenuation becomes of capital importance as vibration amplitudes are directly related to fatigue and, as a result, to structural integrity In this paper is studied the damping capacity of sandwich structures on a structural element reduced to scale scale from a machine tool namely a column. The rigidity of the material was determined using a Instron 8800 machine. All the procedure is presented in another paper. The medium rigidity for every lateral exterior surface is 0.1712N/mm$^2$

## Experimental part

The study of vibration damping capacity on Polypad material was evaluated by interposing it between a column of the machine tool structure and a rigid surface in two ways:

- by fixing an spindle on the column and varying its speed up to 24,000 rpm continuously and in steps;
- by evaluating the vibration resulting from an impact with a rigid object and determine the logarithmic decrement associated to the damping.

In this study were considered three types of columns with similar dimensions but with different rigidities due to the configuration of the inner ribs, shown in figure 2.

The specimens of Polypad material were interposed between the lower base of the column and a rigid surface as shown in figure 3.

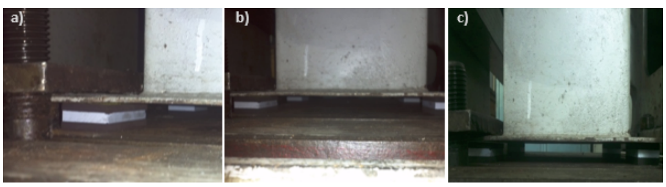


Fig. 3. Interposition of Polypad material between column and a rigid surface

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Fig. 4 a) Fixing the spindle on the column b) fixing the acceleration transducer on the spindle

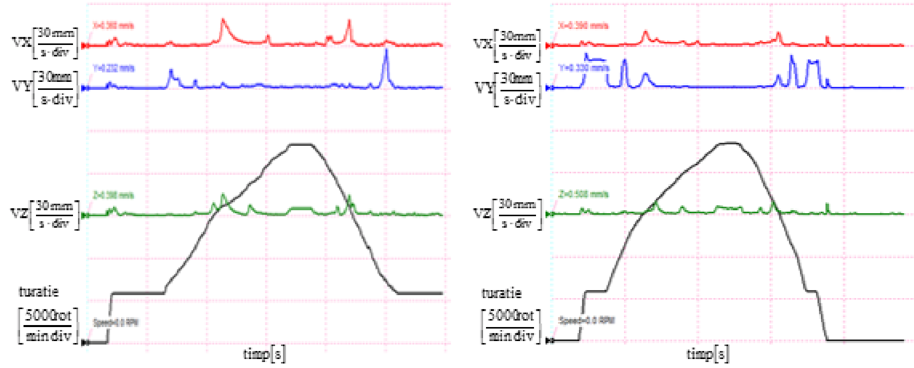


Fig. 5. The analysis of a column with longitudinal stiffeners behavior excited by the action of a spindle whose speed varies continuously

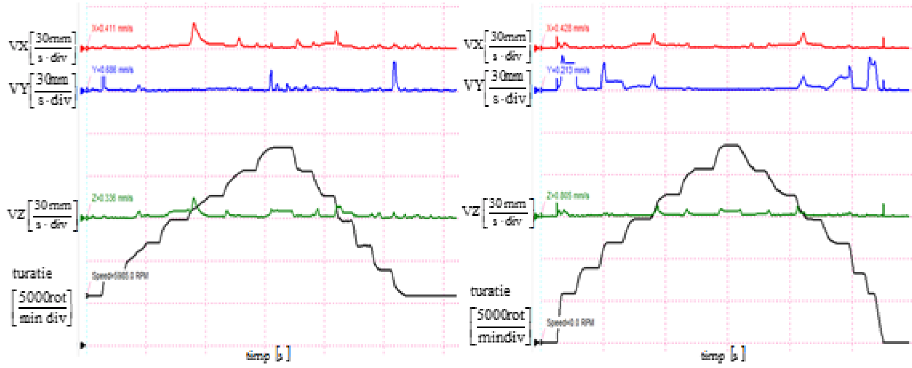


Fig. 6. Column excited by a spindle with speed that varies in steps

The spindle is attached to the column with bolted joints. The vibration assessment was performed using a piezoelectric acceleration transducer that has the possibility of making simultaneous measurements in three directions. In figure 4 is shown the mounting of the spindle on the column; at the end of the spindle is fixed the acceleration transducer.

To measure the speed of the spindle it was used a tachometer which was connected to the data acquisition system.

## Results and discussions

In the experimental research was done a comparison in terms of vibration velocity of a structure where the column was fixed on rigid foundation and in the case when between them a Polypad composite material with elastic and damping properties was interposed. Tests were performed for the three configurations of the column presented.

Figure 5 shows the dependence between the spindle speed versus time and vibration velocity structure in all three directions. For this measurement the spindle speed was varied continuously between 5000 rpm and 24000 rpm. It can be seen that the maximum speed has a higher values of oscillation when the column was rigid fixed in all three directions. When between the column and rigid foundation was interposed an elastic damping material the maximum oscillation speed had disappeared or have been divided into vibration speed and hence lower amplitude.

The Polypad material presents damping characteristics both in high frequencies domain encountered in the operation of machine tools and at the low and middle frequencies that are characteristic for the acceleration or deceleration of a machine tool during the work with slow or transients speed.

In figure 6 is presented the analysis of vibratory behavior of a column with longitudinal reinforce considering that the spindle speed varies in steps. It can be seen that by using Polypad material is obtain a vibration damping, particularly at high frequencies.

There are still some peaks in the variation area of the spindle speed because at some point its frequency has the same value as one of the column natural frequencies.

The impact test was conducted to determine the logarithmic decrement of damping vibration column where between its surface and a rigid foundation was interposed a Polypad material. The procedure consisted of recording the vibrations produced at the impact with a rigid body. In figure 7 is shown the variation graph of the acceleration in the direction were the column was acting. To see the configuration of the picked signal the diagram is increases and the values for the corresponding peaks are read. Figure 8 shows the detail of which we can calculate the logarithmic decrement.

Using the relation 1 is obtained the logarithmic decrement knowing that amplitude ratio measured after *n* cycles of oscillation is equal to the ratio corresponding to the maximum acceleration of same cycles of oscillation.

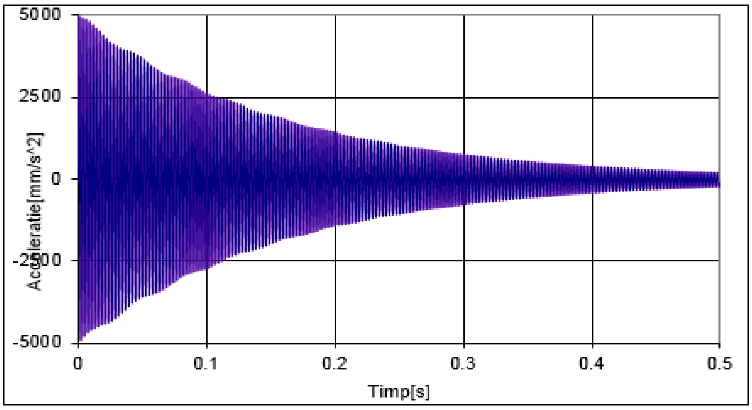


Fig. 7. Acceleration variation

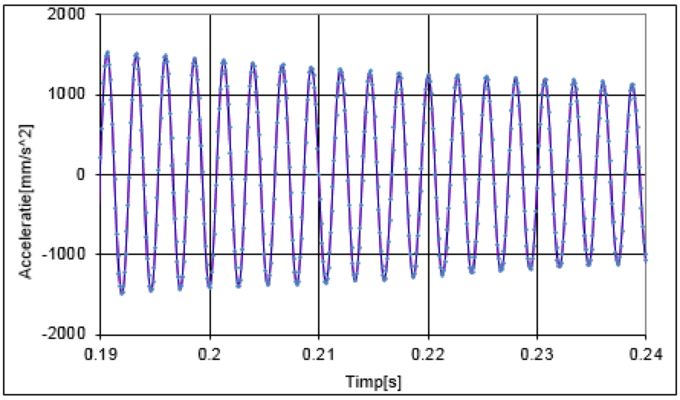


Fig. 8. The detail of which it can be calculated the logarithmic decrement

$$\delta = \frac{1}{18}\ln\frac{1480.3}{1121.5} = \frac{1}{18}\cdot 0.27757 = 0.01542 \qquad (1)$$

In a previous paper were studied the morphology and the structure of the Polypad sandwich composite material used in a machine element [8].

## Conclusions

The possibility of damping vibration in tools machine by using a sandwich composite was tested in two ways:

- by determining the logarithmic decrement associated with an column vibration resulting from impact of a rigid body;

- by fixing the a spindle on the column of varying continuously and in steps its speed in order to determine the frequency range in which the material behaves as a damper, reducing the amplitude of vibration.

Using the combination of laminates composites as faces and materials with low density as core in manufacturing sandwich structures results in materials with high stiffness and strength relative to weight. Sandwich structures are used in high performance applications due to good mechanical properties, excellent corrosion resistance and fatigue strength.

Implementing this composite materials in damper construction between machine tool and his foundation to reduce the vibrations could lead to increasing the precision of machine tools.

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