CONSOLIDATED BEAMS - MECHANICAL PROPERTIES

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ABSTRACT: Composite materials are high-performance materials with superior properties, used in various fields of activity. Thus, they can be used to improve the mechanical resistance properties of some elements used in construction such as beams. In this paper, the behavior under bending stress of some types of wooden beams, reinforced with carbon fiber-based composite materials, was presented.

KEY WORDS: composite, strengthening, beams, forces

1. INTRODUCTION

The composite material is generally composed of at least two components, called matrix and reinforcement which, through their action, contribute to obtaining a material with much better properties, totally different from those of the components that compose it [1-3].
The study of composite materials, their properties and behavior under different types of stress, is a concern of many researchers, as can be seen from the specialized literature [4-7].
The fact that composite materials have significantly superior properties compared to those of classical materials, due to their composition, they end up supporting very well stresses to which other classical materials would yield more easily [8,9]. Composite materials are designed to withstand complex mechanical and physical stresses, ensuring their widespread use in various fields, such as: the energy industry, machine building industry, electronics, the automotive industry, the aerospace industry, medicine, sports and recreational activities, construction, etc. [10-14].

2. TECHNICAL REQUIREMENTS

This paper presents a study of wooden beams, reinforced with carbon fiber composite materials, and subjected to bending stress.
Thus, pine wood beams that were reinforced with carbon fiber composite materials were subjected to bending stress.
In order to highlight the bending behavior of the beams, an experimental stand was used with the help of which the bending force and, also, the displacement of the beams were measured.
On the experimental stand, the beams were subjected to bending stress, determining the force at which their maximum deformation occurred [14].
To reinforce the beams, a composite material of the type fabric based on carbon fiber and epoxy resin was used.
The surfaces of the beams were prepared by cleaning with sandpaper and then the reinforcing material was applied, using the epoxy resin, after which they were left to dry [14].
The beams thus prepared and reinforced were subjected to bending stress on the experimental stand [15].
Following the bending tests performed, the aim was to determine the reinforced beam variant that would present the best possible bending resistance and increased rigidity compared to the unreinforced beam [16].
In figure 1, below, the bending stress of an unreinforced beam, type I, is observed.

This was made by overlapping three pine slats, each with a size of 7x27x120mm (hxlxL), resulting in a package size of 21x27x120mm.

The graph showing the bending behavior of the unreinforced beam is shown in figure 2.

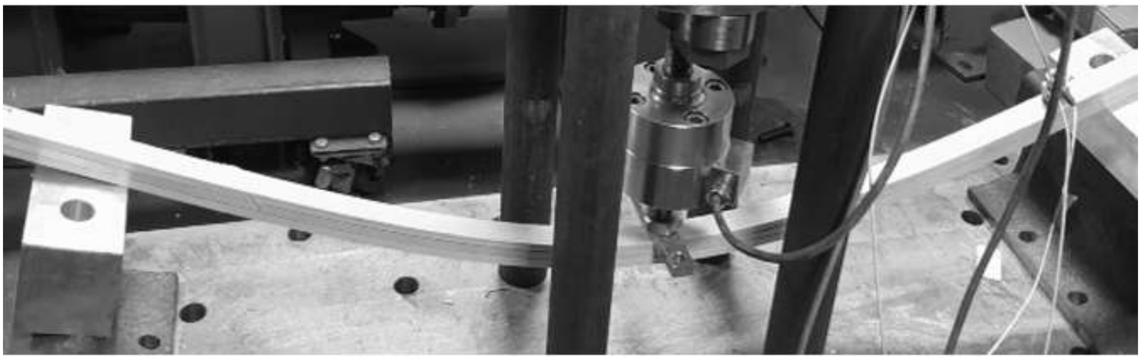

Figure 1. Unreinforced beam type I – bending test

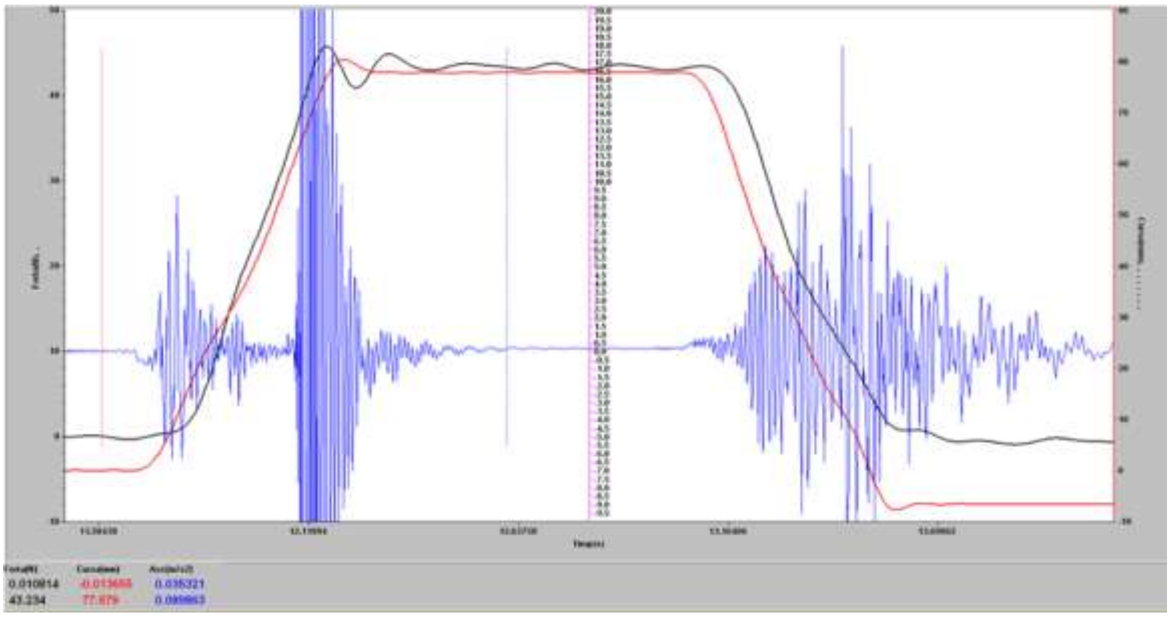

Figure 2. Bending behavior of unreinforced beam type I

It can be seen from the graph that, under bending stress, the unreinforced beam has, in the first part, an almost linear increasing behavior corresponding to an elastic domain, then a short maintenance, followed by the transition to the plastic domain given by its deformation and, finally, by the total rupture. The bending force thus had a value of F=43,234N (black color on the graph) and the displacement of the beam 77,679mm (red color on the graph).

The reinforcement variant for the type I beam was obtained by adding a composite material based on carbon fiber fabric and epoxy resin, between the three pine slats, thus resulting in a beam with dimensions of 23x27x120mm.
The bending stress of this reinforcement variant can be seen in figure 3, below.
Figure 4 shows how the reinforced type I beam was damaged following the bending stress.

Figure 3. Reinforced beam type I – bending test

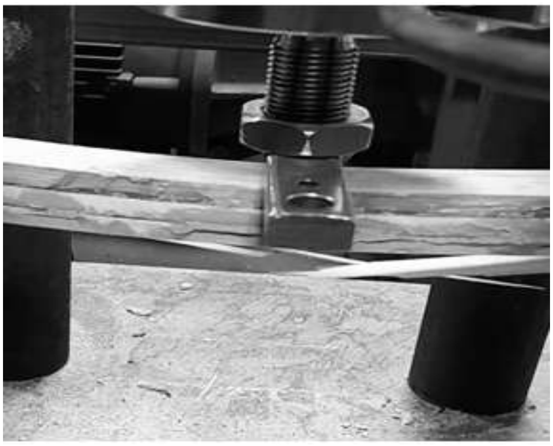

Figure 4. Failure mod of reinforced beam type I (detail)

The graph showing the bending behavior of the reinforced beam I is shown in figure 5. Here too, the behavior of the beam can be observed, which can be considered almost linear increasing, under the action of the bending force, in the first part of the graph, which indicates an elastic behavior, after which deformation and total rupture occur following the bending stress, indicating a behavior in the plastic domain.

The value of the bending force obtained for the reinforced beam in variant I was F=667,47N and the displacement was 80,639mm.

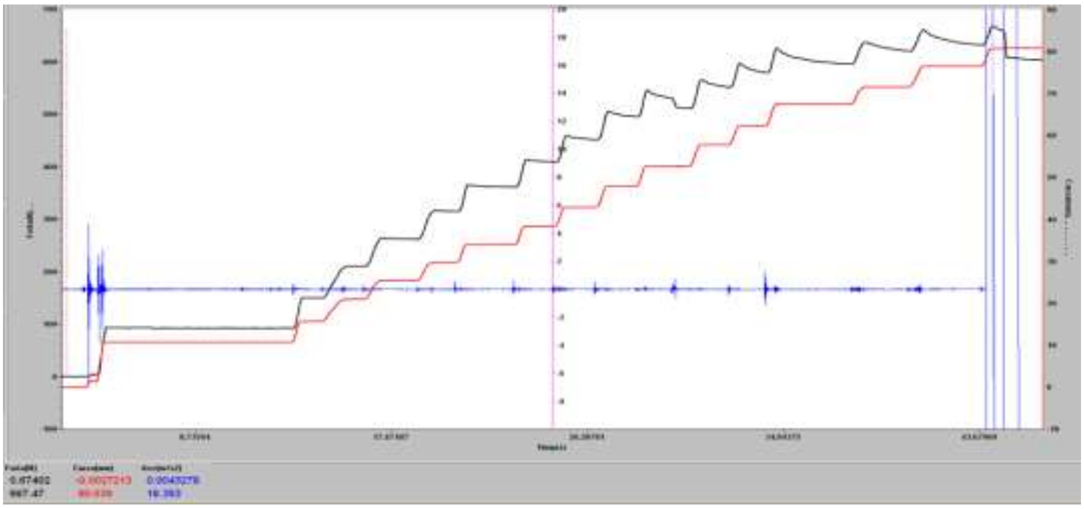

Figure 5. Bending behavior of reinforced beam type I

Another type of beam that was subjected to bending stress is shown in figure 6 below. The type II beam is made of pine wood, with dimensions of 18x27x120mm (hxlxL) and is unreinforced. Following its bending stress, the beam was completely damaged. Figure 7 shows the detail of the beam's failure mode after bending.

Figure 8 contains the graph that highlights the behavior of the type II beam, unreinforced, under bending stress. It can be seen how, following the bending stress, the beam was completely damaged, passing from an approximative elastic domain (with an increasing linear variation of the force) present in the first part of the graph, to the plastic domain. The value of the force obtained is F=249,92N and the displacement of the beam is 69,178mm.

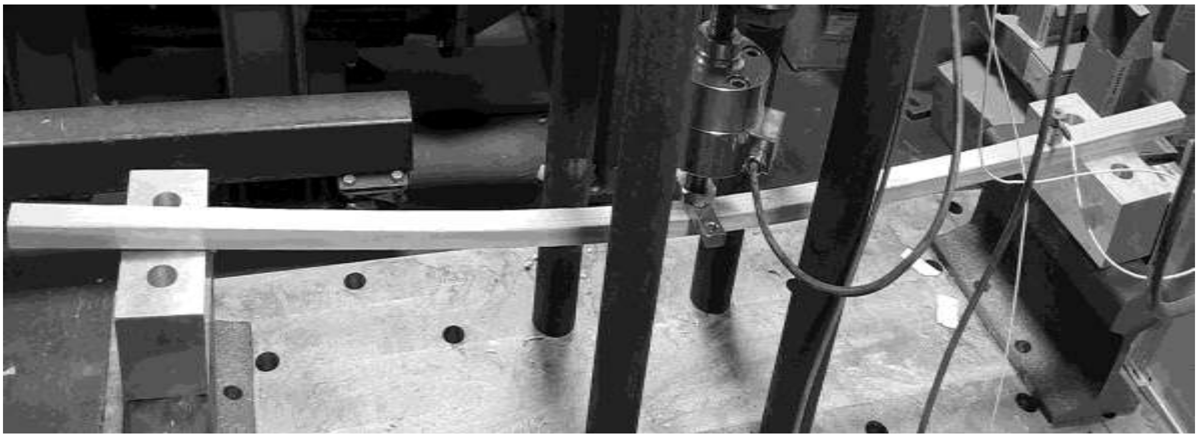

Figure 6. Unreinforced beam type II – bending test

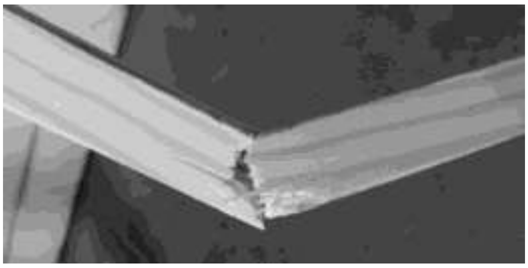

Figure 7. Failure mod of unreinforced beam type II (detail)

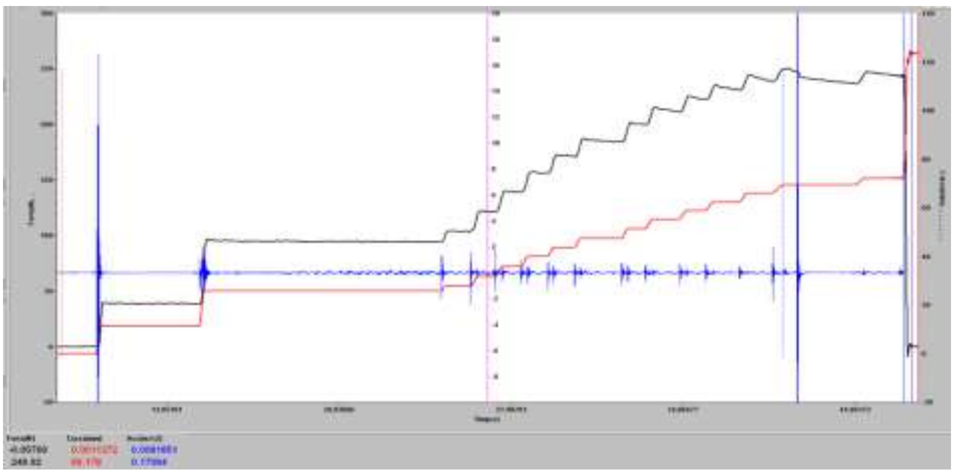

Figure 8. Bending behavior of unreinforced beam type II

The type II beam was reinforced with composite material based on carbon fiber fabric and epoxy resin, so that the fabric covered the beam on three sides (the bottom

and the two side parts), then it was subjected to bending, as can be seen in figure 9 below.
In figure 10, the detail with the failure mode is observed and in figure 11, the graph containing the behavior of the reinforced beam under bending stress is presented. As the other studied beams, the graph shows, in the first part, an approximately linear, increasing variation of the bending force, similar to the elastic domain, after which the beam deteriorates and can be considered to have passed into the plastic domain.

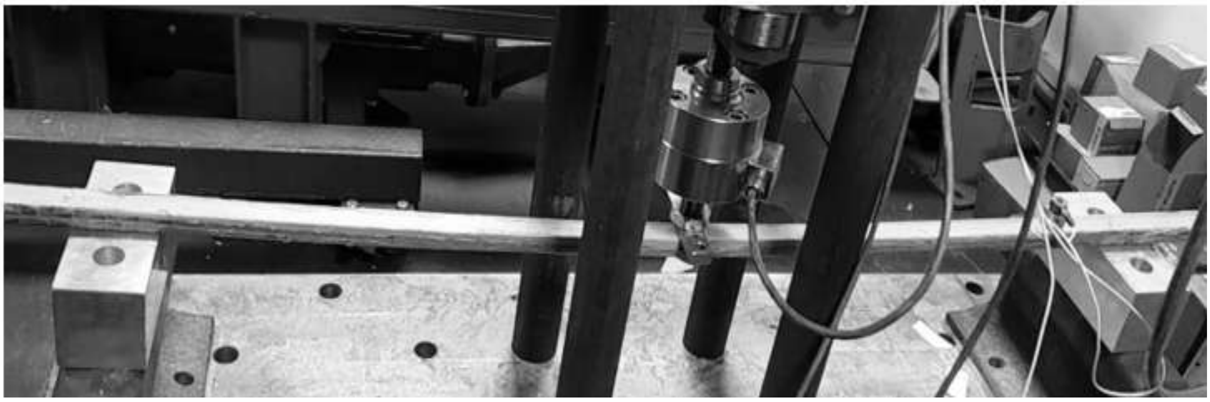

Figure 9. Reinforced beam type II – bending test

Figure 10. Failure mod of reinforced beam type II (detail)

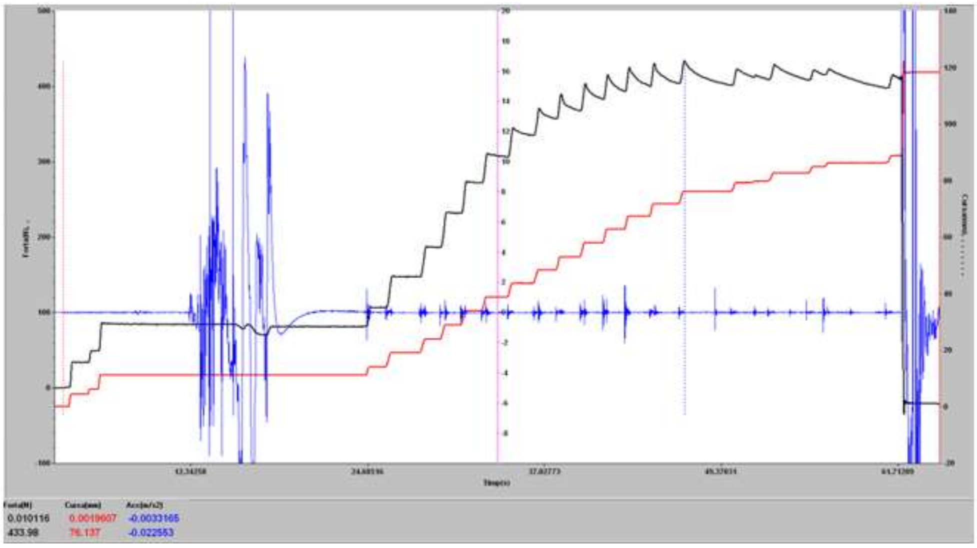

Figure 11. Bending behavior of reinforced beam type II

The value of the bending force is F= 433,98N and the displacement of the beam is 76,137mm.
From the results obtained after performing the bending tests, on the types of beams studied, it was observed that the type I beam reinforce-

ment variant behaved best under bending stress, resisting high values of the bending force.

3. CONCLUSION

In this paper, pine beams were studied, unreinforced and reinforced with composite materials such as carbon fiber fabric and epoxy resin, which were subjected to bending stress. The behavior of the beams under bending stress was determined, which was highlighted in the graphs drawn after bending, thus establishing the reinforcement variant with the highest strength, which could offer the possibility of its application in practice.

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