STUDY OF SISAL REINFORCED CASTOR OIL POLYURETHANE COMPOSITES FOR USE AS WALL PANEL

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Keywords: Composites. Polyurethane. Sisal fibers. Wall panel. Composites

Abstract

Many studies have been conducted with the goal of developing composites for construction. The purposes of this work was produce and analyze the mechanical properties of polymeric composites using a castor oil polyurethane matrix reinforced with sisal fiber to use as wall panel. The composites were produced with randomly distributed 30 mm long sisal fibers, with 35% of fiber volume content and thickness of 3.5 mm. The mechanical properties of these composites were compared with the composites traditionally used at Brazilian market and was observed that the composite showed good results, with great potential to use as wall panel.

1. Introduction

1.1. Composites

Several studies are being conducted to develop composites for application in construction, aiming to generate alternative materials and techniques traditionally used. The development of composites is an important provider of opportunities to improve the standard of living of people in many developing countries, as most of renewable materials are based on agricultural products for as much as their use is widely necessary in industrialized countries.

The composite materials are used around the world for many applications because of their high strength and modulus compared to traditional materials such as metals and woods, along with their long durability [3].

Fiber reinforced composites are widely used in different areas. The fibers are used to prevent the propagation of fissures in the matrix, thus increasing the bearing capacity and delaying fracture. Many researches have been done about natural fibers analyzing the mechanical properties of the composites in function of fiber length, distribution and volume, and the effects of chemical treatments on fibers, [4].

The aim of this study was produce sisal reinforced castor oil polyurethane composites for using as panel in the building. The composites produced were mechanical characterized and their properties were compared with a commercial material, leader in Brazilian wall panel market.

The study wanted to combine sustainable properties of the two materials to produce a biocomposite. Furthermore, sisal fiber has excellent mechanical properties and is very abundant in Brazil

2. Material and methods

The composites produced used the castor oil polyurethane resin as matrix reinforced with sisal fibers. The sisal fibers were donated by Salgadalia Ind. Export Ltda. and polyurethane resin was donated by the company Imperveg Polímeros Indústria e Comércio Ltda. The nonwashed sisal fibers were selected, cutted at 30 mm long and dried at 60 ° C. The fibers were randomly distributed in metallic square forms with dimensions of 20.5 cm x 20.5 cm and mingled with polyurethane resin castor oil (Fig. 1). The composites were pressed at room temperature for 24 hours to obtain sheets with a thickness of about 3.5 mm.

Figure 1. Production of sisal reinforced castor oil polyurethane composites

The mechanical properties of the produced composites were compared at a commercial wall panels, which has been the leadership of the brazilian wall panel market for decades. The material is produced by pressed eucalyptus fibers finished with melamine resin of low pressure with 3.5mm of thickness.

The specimens were cut by laser in the dimensions and format according to the ISO 14125:1998 e ASTM D638:2012, Fig. 2 e Fig. 3, for the flexure and tensile tests respectively [1,2].

a) 

b)


Figure 2. Specimens for flexure test: a) commercial sheet; b) sisal reinforced castor oil polyurethane composites

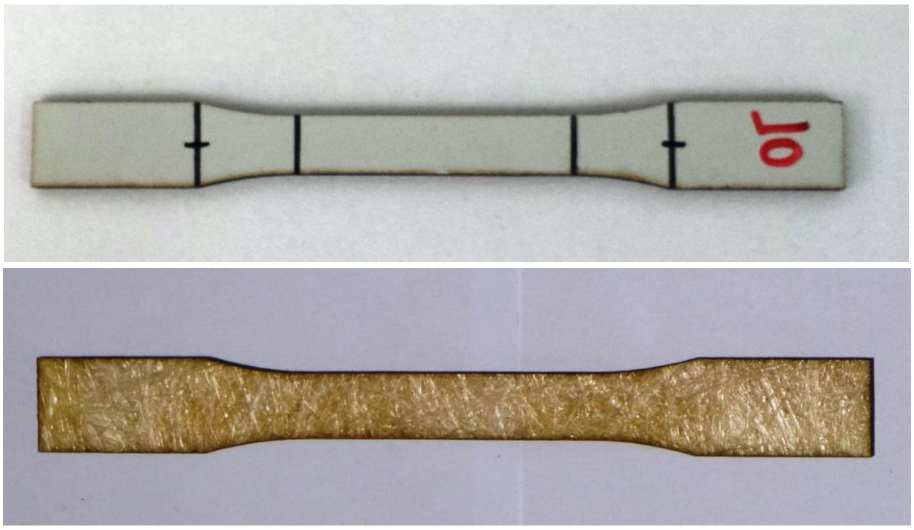
a)
b)


Figure 3. Specimens for tensile test: a) commercial sheet; b) sisal reinforced castor oil polyurethane composites

The tensile and flexure test were performed in an Instron universal test machine, model 5982, with load cell of 100 kN for the tensile test and 5 kN for the flexure test (Fig. 4). The number of test specimens was nine for the tensile test and fourteen for the bending test. The displacement rate was of 2 mm/min and the tensile strain was determined by an Instron extensometer.

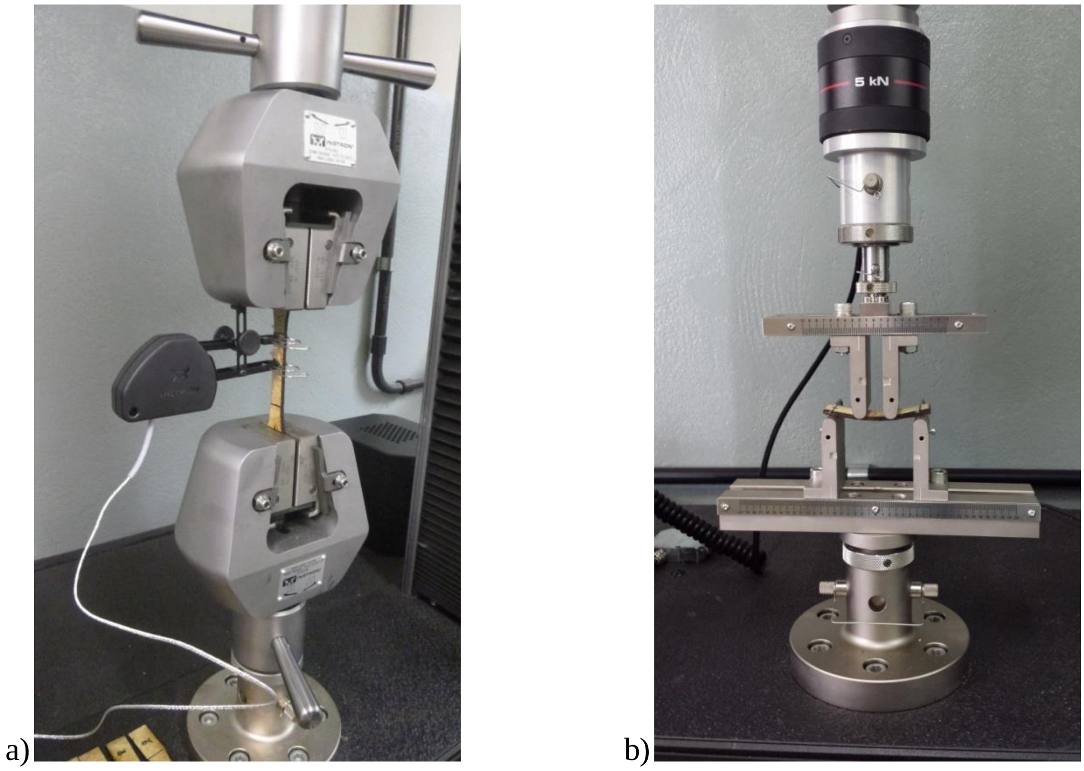
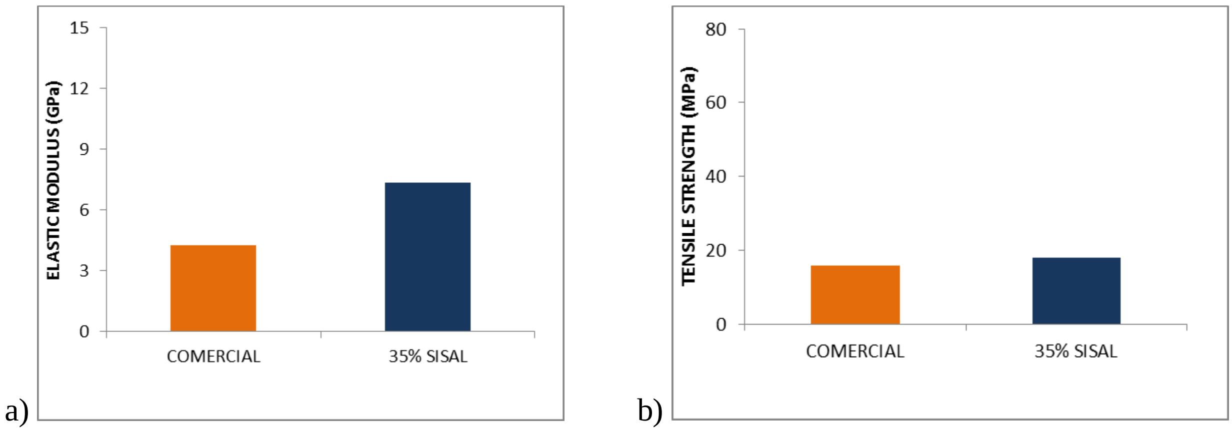


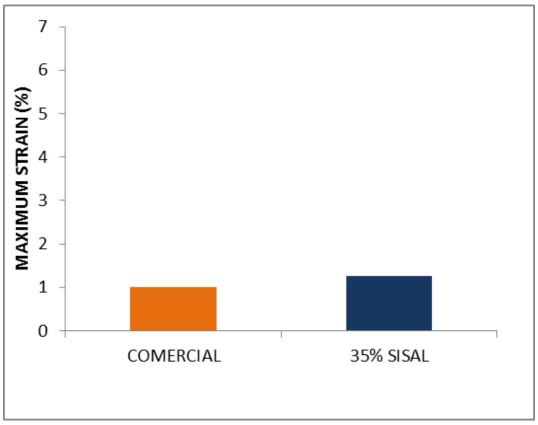
Figure 4. a) tensile test; b) flexure test

From the tensile test, the elastic modulus, tensile strength and maximum strain of the composite were determined. From the flexure test, the maximum flexural stress, flexural modulus and the deflection were determined.

3. Results

The sisal reinforced castor oil polyurethane composites presented elastic modulus of 7.33 GPa, tensile strength of 18.1 MPa and the maximum strain was 1.26%, while the commercial material presented 4.23 GPa, 15.79 MPa and 1% for the elastic modulus, tensile strength and maximum strains, respectively. Therefore, as can be seen in Figure 5, the properties of the sisal reinforced castor oil polyurethane composites showed superior then commercial material, reaching an increase of approximately 73% e 15% for the modulus of elasticity and tensile strength, respectively.





c)

Figure 5. Mechanical properties of composites in tensile test: a) Elastic modulus; b) Tensile strength; c) Maximum strain

The Fig. 6 shows the results for the flexure test. It can be seen that the produced composites had properties similar to the commercial material, with the exception of greater flexibility.

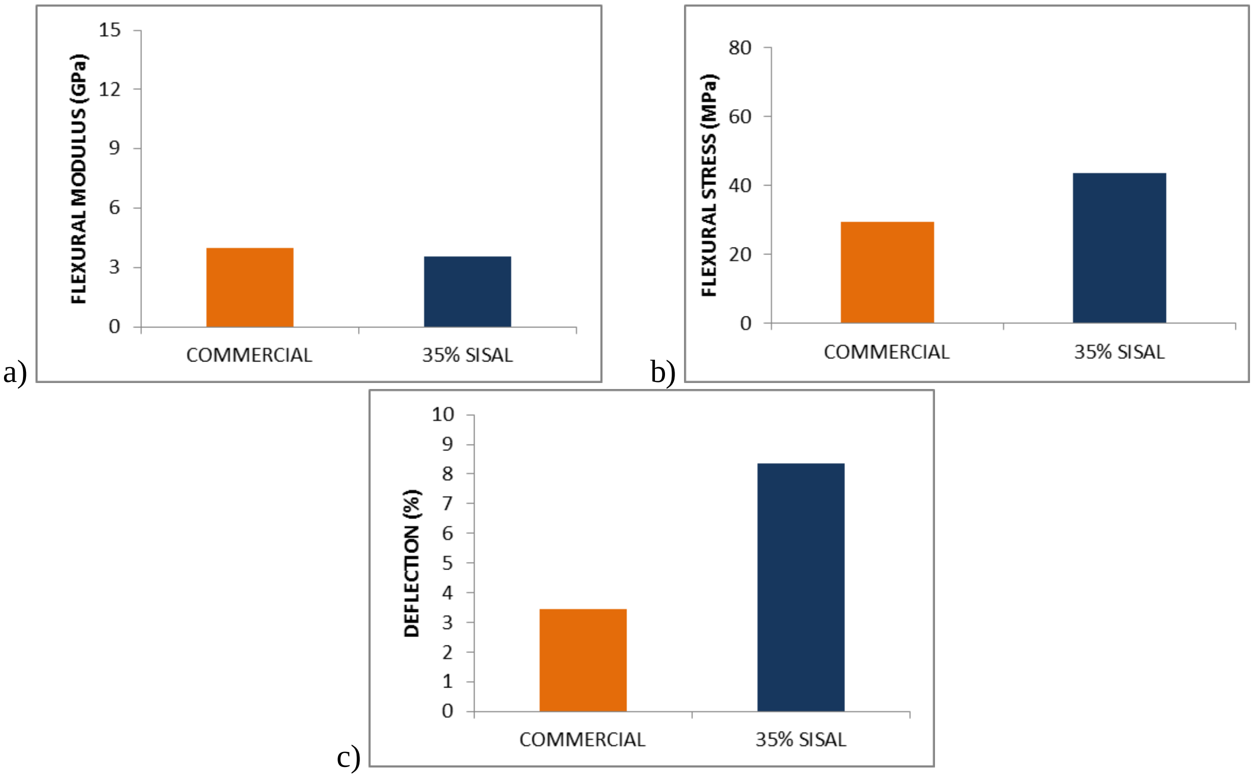


Figure 6. Mechanical properties of composites in flexure test: a) Flexural modulus; b) Maximum flexural stress; c) Deflection

4. Conclusions

The sisal reinforced castor oil polyurethane composites produced showed similar or higher mechanical properties of the commercial material. From the results obtained it can be concluded that even produced from natural materials and fibers arranged randomly, its behavior is equivalent with the commercial material and has potential for large-scale production. Further study should be conducted to evaluate the physical properties of the composite and its economic viability necessary for using as wall panel.

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