# DEVELOPMENT AND ASSESSMENT TO ENVIRONMENTALLY FRIENDLY NATURAL FIBER COMPOSITES

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## ABSTRACT

Two different types of natural fibers (jute and sisal) were studied and characterized, using optical microscopy, pycnometry density, single filament and linear density tests. Jute fibers were processed into composite parts from woven fabrics raw-material and sisal fibers were also processed into final composite components but in the form of chopped mat. Those fibers were used to reinforce polyester and epoxy matrices and therefore produce composite plates by resin infusion molding. Finally, the final obtained composite plates were submitted to mechanical testing, in order to assess their relevant mechanical properties.

## INTRODUCTION

During the past few decades, polymer matrix composites replaced, advantageously, many conventional materials, in various applications. This was possible because these materials have low density, excellent mechanical behavior and can be easily processed. The large majority of composite structures still use thermosetting matrices, like polyester or epoxy systems, even if, more recently, thermoplastic matrices are starting to be studied. (Mazumbar, 2012, Nunes, 2003).

Recently, because of their interesting properties, natural fibers are being studied as reinforcement material in composite components. Usually they are low-costly, combine very low density with high specific properties, are biodegradable and nonabrasive, unlike other reinforcing fibers and also readily available (Saheb, 1999).

## *RAW MATERIALS AND COMPOSITE PROCESSING*

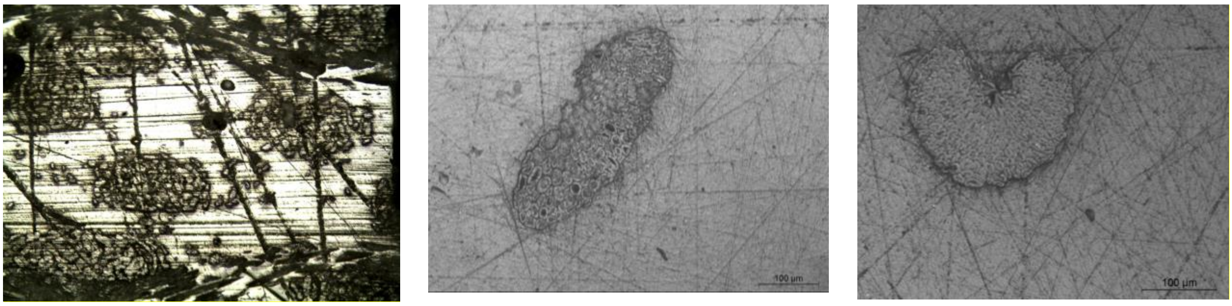
Jute and sisal fibers, chosen to be studied in this work, are between the most successfully used natural fibers as reinforcements in composite structures. The different natural fibers were impregnated and consolidated with two different thermoplastic resins: one orthophthalic polyester resin and one epoxy.

Fibers were impregnated, at room temperature, by hand lay-up, with polyester and epoxy resins. Then, vacuum molding was employed to allow establishing a controlled consolidation pressure.

## *RESULTS*

Microscopy obtained images are depicted in figure 2.

Fiber characterization results are summarized in tables 1 and 2.



a) Jute fiber (50×) b) Sisal fiber (100×) c) Sisal fiber (100×)

Fig. 2. Typical jute and sisal fiber geometries. Sisal fibers have two typical shapes, shown in pictures b) and c)

Table 1 Sisal single filament test results

| **Gage length** | **Deformation at break** | **Tensile strength** | **Tensile modulus** |
|---|---|---|---|
| (mm) | (%) | (MPa) | (GPa) |
| 20,00 | 3,22±0,28 | 760±114 | 28,1±0,97 |
| 25,00 | 2,81±0,70 | 763±9,2 | 19,4±0,66 |
| 30,00 | 2,64±0,42 | 461±185 | 14,7±0,13 |

Table 2 Jute plain woven fabric specifications

| | |
|---|---|
| Mass (g/m$^2$) | 204.0±7.0 |
| Warp | |
| Linear density of the yarn (Tex) | 140.5±9.5 |
| Density (yarns/cm) | 7.0±0.1 |
| Crimp (%) | 5.04±0.89 |
| Weft | |
| Linear density of the yarn (Tex) | 142.6±19.1 |
| Density (yarns/cm) | 6.6±0.5 |
| Crimp (%) | 2.44±1.24 |

Mechanical test results, for polyester matrix composites are summarized in table 3.

Table 3 Mechanical test results of jute and sisal polyester matrix composites

| | ***Fiber type*** | ***Strength (MPa)*** | ***Elasticity modulus (GPa)*** | ***Deformation at break (%)*** |
|---|---|---|---|---|
| *Tensile* | *Jute* | *57,0±7,2* | *7,0±0,5* | *1,9±0,2* |
| | *Sisal* | *24,8±3,9* | *5,4±0,3* | *1,5±0,3* |
| *Flexural* | *Jute* | *91,5±3,8* | *5,9±0,2* | *2,8±0,1* |
| | *Sisal* | *54,8±1,9* | *3,9±0,2* | *2,4±0,1* |

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