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Green Composites based on Kenaf Fibers

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Abstract. Natural fibers have recently become attractive to automotive industry as an alternative reinforcement for glass fiber reinforced thermoplastics. The best way to increase the fuel efficiency without sacrificing safety is to employ fiber reinforced composite materials in the body of the cars so that weight reduction can be achieved. The latest thermo plastic developments have resulted in higher material properties and more possibilities in the design of bumper beams. However the use of steel, aluminum, glass thermoplastics, sheet metal components, bumpers becomes at higher cost than long fiber reinforced thermoplastics.

Introduction

Kenaf - *Hibiscus cannabinus*, is a plant in the Malvaceae family. It is in the genus *Hibiscus* and is probably native to southern Asia, though its exact natural origin is unknown.

The name also applies to the fibre obtained from this plant. Kenaf is one of the allied fibres of jute and shows similar characteristics. It is an annual or biennial herbaceous plant growing to 1.5 - 3.5 m tall with a woody base. The stems are 1 – 2 cm diameter, often but not always branched. Theleaves are 10 – 15 cm long, variable in shape, with leaves near the base of the stems being deeply lobed with 3 - 7 lobes, while leaves near the top of the stem are shallowly lobed or unlobed lanceolate. The flowers are 8 – 15 cm diameter, white, yellow, or purple; when white or yellow, the centre is still dark purple. The fruit is a capsule 2 cm diameter, containing several seeds. Since the paper pulp is produced from the whole stem, the fiber distribution is bimodal. The pulp quality is similar to hardwood (Fig. 1 and 2). The most used composites materials based on kenaf are:

- composite containing cellulose paper as reinforcement and synthetic phenolic resin as matrix;
- composite containing cotton fabric as reinforcement and synthetic phenolic resin as matrix;
- composite containing glass fabric as reinforcement and synthetic epoxide resin as matrix;
- composite containing glass fabric as reinforcement and synthetic phenolic resin as matrix.


Fig. 1. Kenaf plants


Fig. 2. Kenaf bast and core fibres

The reinforcement material used in the composites is impregnated with a resin when a preform is obtained. With the impregnation process a complete wetting of fibers with the matrix is performed lake a transparent film. In the preform itself the resin is transformed from A to B stages that is form liquid and soluble phase into a solid, partly melt able phase suitable for processing.

Basic parameters in the process of preform production are: content of matrix, uniformity of matrix along overall surface of reinforcement, gel time, matrix flow, moisture content and volatiles materials.

Properties of kenaf fibres preforms

The available kenaf fibers samples, were delivered as preforms already impregnated with thermoplastic resins. The properties of kenaf / biocomp (kenaf 80%, resin 20%) the preforms are given in table 1:

Table 1. Properties of Kenaf / biocomp preforms.

Property	Measuring Unit	Kenaf fibres performs
Resin type	-	thermoplastic
Resin content	%	20
Specific weight	Kg/m^3	58
Thickness	mm	8-10

The composite have been constructed by laying up a multiple number of preforms plies, in accordance with the targeted thickness and cured at elevated temperature.

The final composites were prepared of all available kenaf preforms. For comparison with the structural composites kenaf/biocomp composites were tested by the same methods.

The samples of the kenaf fibers preforms are prepared of 7 layers of Isolkenaf (80% kenaf, 20% biocomp) under the following conditions: The final composites were approx. 5 mm thick and weighted approximately 5,4 kg/m^2. The size of the composite plates is chosen for best utilization of the material since the test specimen has to be 120 mm long. Specimen dimensions were according to the respective standards and tested in a universal testing machine (Fig. 3). All the mechanical properties obtained are given in table 2.

In Fig. 4 and Fig. 5 are given the diagrams for the obtained composite material in comparison with the results for other equivalent materials.

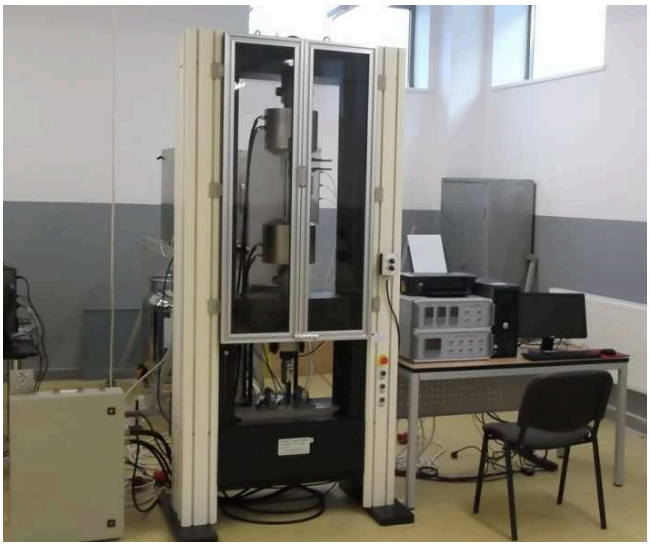

Fig. 3. Universal testing machine type WDW 150S

Table 2. Basic physical and mechanical properties of kenaf/biocom composites.

Property	Measuring Unit	Composite Kenaf/biocom
Specific weight	g/cm^3	0,91
Flexural strenght	MPa	32,12
Flexural modulus	GPa	9,32
Impact strenght	kJ/m^2	40,34
Compression strenght	MPa	16,82

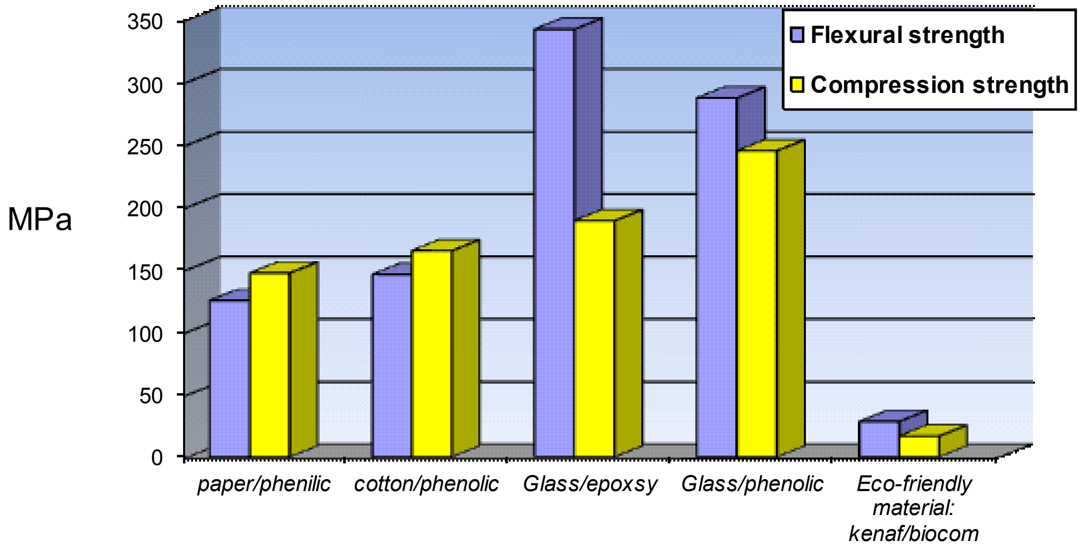

Fig. 4. Flexural and compression strength for all composites

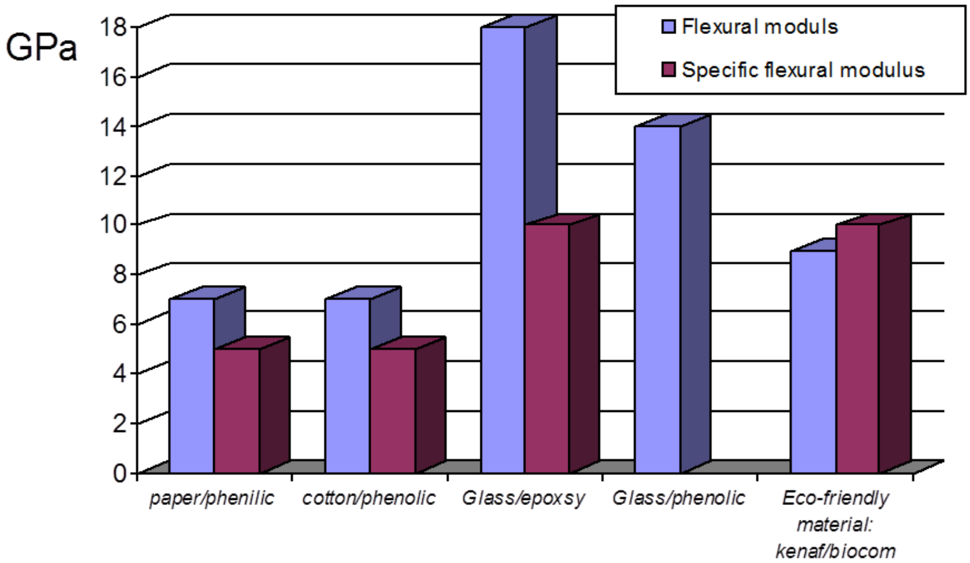

Fig. 5. Flexural modulus for all composites

It is shown that the eco-friendly material studied like kenaf / biocom has medium/good results for specific flexural modulus and very bad results for flexural and compression strength, in comparison with other composites mentioned in the Figures 4 and 5.

In another point of view, water absorption and specific weight of kenaf fiber composites are important characteristics that determine the end use applications of these materials. Water absorption could lead to a decrease in some of the properties and should be considered when selecting applications. Water absorption in kenaf fiber composites can lead to a build-up of moisture in the fiber cell wall and also in the fiber-matrix interphase region which would result in fiber swelling and affect the dimensional stability. Good wetting of the fiber by matrix and adequate fiber-matrix bonding can decrease the rate and amount of water absorbed in the interphasical region of composite.

A typical kenaf – biocom (80 / 20) composite has higher water absorption (30%) compared to a structural composites. It is therefore, very important to select applications where this high water absorption is not a critical property.

Conclusions

One of the big areas of development is in combining natural fibers with thermoplastic materials. The primary advantages of using natural fibers as reinforcements in plastics are numerous. Such fibers may exhibit low densities, high specific properties, easily recycled no brittle fibers, sharp curvature allowances, and biodegradability.

Combining kenaf fiber with other materials provides a strategy for producing advanced composite materials that take advantage of the properties of both types of materials. It allows the researchers to design materials in accordance to the end - use requirements within a framework of cost, availability, recyclability, energy use and environmental considerations. Kenaf fibers are a potentially outstanding reinforcing filler in thermoplastic composites.

All these properties obtained for the new materials, gives to designers the rights to decide the opportunities for using them in automotive parts or other pieces with different destinations.

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