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Tensile and Flexural Properties of Natural Fibres (Kenaf and Flax) Mat Hybrid Composite Material

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ABSTRACT

Natural fibres used are kenaf, flax, sisal and aloe Vera fibres etc. in the form of biaxial mats to make a hybrid composite material and it is the preferred choice due to its superior properties like low density, stiffness, light weight and possesses better mechanical properties. Natural fibres are able to replace the synthetic fibres that it has the eminent benefits of like small manufacturing cost, its availability, ease of manufacture, low development energy, non-abrasive, worthy acoustic property, biodegradability, reasonable mechanical strength, renewability. Composite were made-up by hand lay-up method with the biaxial mats of natural fibres and epoxy resin in a mould and cured under gradual pressure. In this research paper mechanical behaviour such as tensile and flexural prperties of natural fibres kenaf /flax mat reinforced hybrid composite materials (KFK) were studied. It is found that the composite of (kenaf/flax/kenaf) mat of natural fibres gives better tensile and flexural properties in comparisons to (glass/flax/glass) mat of natural fibres. Sample was prepared and tested accordance to the ASTM standards. The tensile and flexural are mechanical properties of natural fibre epoxy composite in the mat form are increasing and it is found to be maximum at 40% by wt. of mats.

Keyword : KFK- Kenaf and Flax Fibre Reinforced Epoxy Composite Laminate Hand lay-up.

I. INTRODUCTION

Focus on the development of natural fibres like jute, coir, sisal, pineapple, ramie, bamboo, banana etc., is to explore its application in low load condition. Composites, the wonder material with light-weight, high strength-toweight ratio and stiffness properties have come a long way in replacing the conventional materials like metals, woods etc [1]. Composite materials produce a combination properties of two or more materials that cannot be achieved by either fibre or matrix when they are acting alone [2].Natural fibre like sisal jute banana hemp coconut palm cotton bamboo and wood has been used as reinforced in polymer composite in recent year .The property of natural fibre composite depends upon fibre matrix and interaction them [3]. Synthetic fibre based composite is replaced by the bio based composite because the synthetic based composite consists of the gasoline built artificial fibres and resins [4]. The natural fibre is more unfailing and abundantly obtainable substitute to exclusive and non-reliable artificial fibres [5]. The strength of the natural fiber reinforced hybrid composite depend upon the chemical stability, fiber strength, bonding between the matrix and reinforced material to permit stress transfer, fibre strength[6]. Basically, composite is defined as the material consisting of binder which is a continuous phase and the fibrous filler as reinforcement which is the discontinuous phase

[7].There is an increasing demand from automotive companies for materials with sound abatement capability as well as reduced weight for fuel efficiency. Natural fibres possess excellent sound absorbing efficiency and are more shatter resistant and have better energy management characteristics than glass fibre reinforced composites [8].

Natural fibres, classified as lingo cellulosic materials, have been used as reinforcement material once present innumerable advantages, such as: low specific mass, easy handle, biodegradability and renewable resource, insulator thermal, electric and acoustic, aesthetic aspects, non-toxic, beyond low cost[9]. Sisal fibre is one of the most widely used natural fibres and is very easily cultivated. It has short renewal times and grows wild in the hedges of fields and railway tracks [10]. Concerning the environmental and ecological issues natural fibres have the point of attention for the polymer composite due to their advantage over the glass and carbon fibre composite [11]. Asian researchers are showing interest in cellulose fibre reinforced plastics, advantage of these fibres as reinforcement is their low density, which is an important factor of consideration in the structural industry. Widely there are many research works are on-going in this regard [12].

II. METHODS AND MATERIAL

Kenaf Mat

Kenaf fibre is one of the famous natural fibres used as reinforcement in polymer matrix composites (PMC). Kenaf, known as *Hibiscus cannabimus L*, is an herbaceous annual plant that grows in a wide range of weather conditions, growing more than 3 m within 3 months (Nishino et al., 2003). The highest growth rate may up to 10 cm/day [13]. It is purchased by the Viruska composite, vijaybada.

Table 1: Chemical properties of Kenaf Fibre [14]

Cellulose	66.47%
Lignin	2.39%
Holocellulose	75.43%
Hemicelluloses	9.43%
Extractive	2.11%

Figure 1-Kenaf Mat

Flax Mat

Flax fibre comes under the category of bast fibre and is extracted from the plant of the linseed/flax plant. This plant is popular for two reason: one is flax fibre and another is linseed oil (used for industrial applications) extracted from the seed of the plant (Basu and Dutta, 2014).The flax variety tends to grow taller, more slender, and with less branches. It is cultivated in order to extract the very long fibers from inside the wooden stem of the plant, which are then spun and woven into linen fabric. The taller the flax plant, the longer the fibre. It is purchased by the Viruska composite, Vijaybada.

Table 2: Chemical properties of flax fibre [14]

Cellulose	71-78%
Hemicellulose	18.6-20.6%
Lignin	2.3-3%
Pectin	2.3-2.5%
Ash	1.5%
Wax	1.7%

Figure 2-Flax Mat

Epoxy Resin

Epoxy is either any of the basic components or the cured end products of epoxy resins, as well as a colloquial name for the epoxide functional group. Epoxy resins, also known as polyepoxides, are a class of reactive pre-polymers and polymers which contain epoxide groups.

Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerisation, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and this (usually called mercaptans). These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referred to as curing For epoxy hardener as a preserving agent. Hardener work as a catalyst when combine with resin. It hardens the material due to evolution of heat by the exothermic reaction. The Mixing of epoxy with hardener provide the good characteristics for the environment. HY951 is used as a hardener in this experiment.it contains the 10-20MPa viscosity with 250C. Epoxy is procured by the Singhal Traders, Meerut. It is the part of thermosetting resin. Araldite LY 556 epoxy manufactured by the Huntsman Advanced Materials which follow the certain properties which is used by the matrix materials.

Figure 3- Epoxy and Hardener

FABRICATION

First of all a wooden frame of dimension (300x250x6mm) is prepared. A marble mould is used for fabrication of composite by hand layup method as shown in figure 5. Natural fibres mat (Kenaf and Flax) were cut as per frame cavity. In this work the resin used is Epoxy resin (LY 556) and the hardener used is Araldite HY-951, the matrix is prepared by mixing the resin and hardener in the ratio of 10:1. The matrix is poured on the mould within the frame and is properly spread .Wax is used as a releasing agent for easy removal of composite. Firstly a sheet of kenaf mat is layed over the matrix within the frame and then again a layer of matrix is uniformly spread. It is followed by placing a flax mat over the matrix and is repeated to achieve a final composite comprising of two kenaf mats and a flax mat in between. The mould is closed and a fixed load is applied through the C-clamp and is left for the 48 hours at 55% humidity at room temperature for curing.

Figure 4-Frame

Figure 5-Mould

Finally, the hybrid composite sheet is obtained having a dimension of (300×250×6) mm. It is characterized by the different mechanical parameters like tensile and flexural test. It is cut by the diamond tip hand cutter.

Figure 6-Final composite sheet

Figure 7-Side view of the final composite

III. RESULTS AND DISCUSSION

Tensile Testing

The Tensile test is carried out in universal testing machine accordance with ASTM D-638 standard. The testing out carried out on central institute of Plastic engineering and technology Lucknow up universal testing machine code no. PTC/083/ME having maximum working ranges 100 kN and accuracy ± 0.06%. Through this testing the ultimate tensile strength, modulus value and strain determined. The specimen is hold by the grip and load applied until the failure occurs. Figure 8(a) and 8(b) shows the digital UTM machine before and after holding the specimen in the jaw.

Figure 8(a) - Digital UTM

Figure 8(b)-Specimen fixed hinged job

Figure 9(a) & 9(b) shows the tensile test of the specimen before and after fracture respectively. It shows that breaking obtained at the neck points

Figure 9(a)-Tensile Specimen before Fracture

Figure 9(b)-Tensile Specimen after Fracture

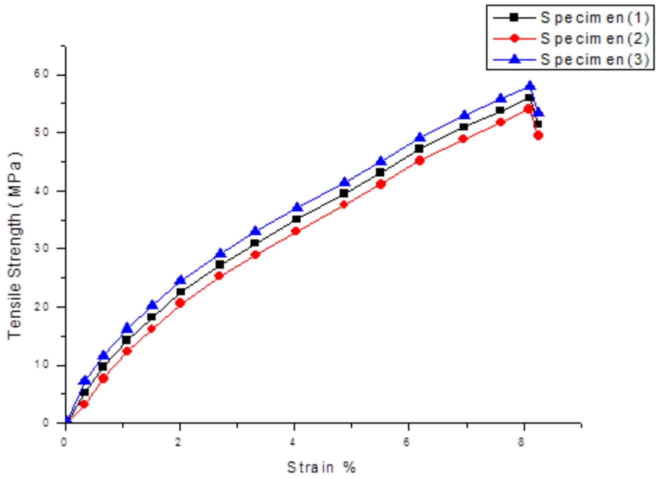

Figure 10-Stress strain curve

Obtained value from curve

Ultimate Tensile Strength – 56 MPa
Young Modulus- 495 MPa

Flexural Test

The flexural test is carried out in a Universal Testing Machine and it is made by INSTRON, USA and there is a code no. PTC/083/ME. There is a working range maximum 100 kN and accuracy is ±0.066%. It is used for mechanical property. The Flexural test is carried out in a UMT no samples cut in accordance with ASTM D-790 standard the testing procedure is as per the three-point bending test by placing the specimen on the Universal Testing Machine and applying load till the specimen fracture and break. Result is compared and flexural strength of the material is identified. The samples of the specimen before and after test presented in Figure 12(a) and Figure12 (b).

Figure 11- Flexural Machine

Figure 12(a)-Flexural Specimen before Fracture

Figure 12(b)-Flexural Specimen after Fracture

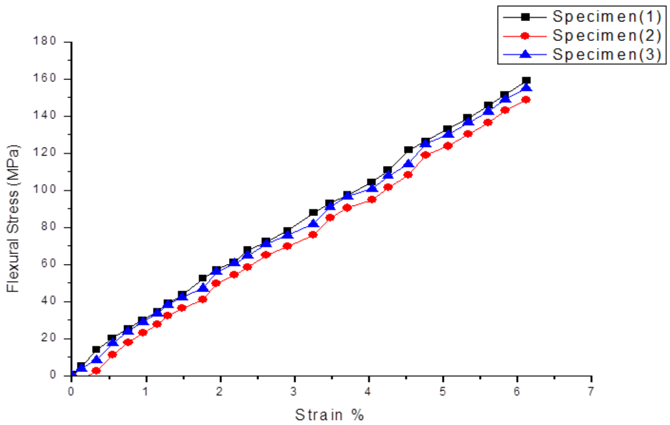

Figure 13: Flexural stress vs. strain

Obtained value from curve

Flexural stress at maximum flexural load -158.97 MPa
Young Modulus- 2957.16 MPa

IV.CONCLUSION

The present work is carried out to find out the tensile and flexural strength of natural fibres (kenaf and Flax) mat hybrid fibre reinforced epoxy composite and following conclusion are made-

1- This works shows that successful fabrication of (kenaf & flax) mat with epoxy resin composite laminates is possible by hand lay-up methods.

2- The ultimate tensile strength of (kenaf & flax) mat is 56 MPa which is higher than jute/sisal/glass, glass/flax/glass and Jute/Banana/Glass Hybrid Composite Materials.

3- The tensile test result is showing good mechanical strength other than (jute +sisal +glass) and (jute +banana + glass) hybrid composite material [15][16].

4- The flexure stress at maximum flexure load of (kenaf& flax) mat is 158.97 MPa which is higher than jute/sisal/glass, glass/flax/glass and Jute/Banana/Glass Hybrid Composite Materials. The flexural strength values of this hybrid fibre reinforced composite are reasonably good. [15][16]

From the above absorption, it is understood that fabrication of natural fibres with hybrid fibre composites can be used as an alternate for glass fibre composites depends on the strength required by which the synthetic content in polymeric matrix composite can be reduced.

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