FLEXURAL AND TENSILE PROPERTIES OF KENAF AND GLASS FIBER HYBRID COMPOSITE

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Abstract: The present work focus on the tensile and flexural properties of short kenaf and glass fiber hybrid composite. Kenaf is a valuable natural fiber with robust mechanical properties and is most abundantly available. The kenaf fibers are chemically treated with 4% of sodium hydroxide (NaOH) dilute solution and dried for 24 hours at room temperature. In present work short fibers of lengths 4mm, 8mm are used and deals with fabrication of kenaf and glass fiber hybrid composite. The fabrication involves mixing of kenaf and glass fiber with epoxy resin by hand-layup process and applied pressure at room temperature. The specimens were subjected to flexural and tensile testing's as per ASTM standards. The treatment of fibers shows a significant improvement in flexural and tensile properties. The composite with 8mm-T fiber exhibits better properties than other composite laminas.

Index Terms – Hybrid Composites, Mechanical Properties.

I. INTRODUCTION

Now-a-days, the world is focusing on the new class of materials that are biodegradable in nature. Natural fiber composites gain the attention of many researches and engineers, because it offers low density, low cost, low environmental impact and better mechanical properties. They are used in fields of automotive, ship building, food packing, aerospace and construction etc. Natural fibers such as flax, cotton, hemp, jute, kenaf, sisal, banana, ramie etc., are the most commonly used as reinforcement in composites. Despite of its advantages, these natural fibers have poor moisture resistance which results in swelling of fibers. However this can be overcome by hybridization of natural fibers with synthetic fibers. This approach not only enhances the mechanical properties but also the moisture resistance of the hybrid composite.

The natural fiber that was used in the present study is Hibiscus cannabinus. This plant belongs to the Malvaceae family and popularly known as Kenaf. These are mostly grown in Asian countries. Kenaf has a single, straight and branchless stalk. The fiber is extracted from the outer fibrous bark. Because of its low cost and better flexural strength, these are used in making ropes, bags, rugs and paper. The synthetic fiber used is E-Glass. This fiber is a material consists of extremely fine fibers of glass. These provide the advantages such as light weight, high tensile strength and excellent insulating properties, because of which it has a wide applications in fiber reinforcement industries. The current work is directed towards the fabrication of kenaf and glass fiber hybrid composite using epoxy matrix. The variations in mechanical properties (Tensile and Flexural) are studied.

The study of mechanical properties of Kenaf and Fiber glass Hybrid Composite laminates by Hand layup method was investigated by Z. Salleh, et al. [3]. Short, long fiber and powder fibers are used. The variation of tensile strength on different fiber types was studied. The test results reveals that tensile strength and tensile modulus is found highest for long fiber hybrid composite. From SEM analysis, the surface failure is due to matrix fracture, fiber pull out, fiber- matrix debonding and fiber fracture. MohdSuhairilMeon, et al. [1]used high density Polyethylene (PE) and polypropylene (PP) separately to prepare two sets of short kenaf composite. The kenaf fibers were treated with 3%, 6% & 9% of NaOH for a day and then dried for 24 hours at 80^{o} C. The tensile properties of treated kenaf were improved when compared with the untreated kenaf fibers. Further coupling agents like MAPP, MAPE have amplified the tensile properties of both treated and untreated cases.

S Sivasaravanan, et al. [7] made an investigation on glass fiber/epoxy/nano clay composite by varying Nano clay from 1 to 5 wt% by hand layup process. E- Glass fiber is of bi-directional: 45^{o} orientation is used. The average value of 5% wt of nano clay showed good impact results when compared to the other combinations used. A. Atiqah, et al. [2] developed kenaf –glass reinforced unsaturated polyester hybrid composite. Kenaf and glass fibers are used in mat form. The kenaf fiber was treated with 6% NaOH using Mercerization method for 3 hours. The test results showed that high tensile, flexural and impact strength were obtained using treated kenaf with 15/15 v/v kenaf/glass fibers. The adhesion between the matrix and surface of fiber was enhanced, which plays key role in improving the mechanical properties of KG-UPE hybrid composites. The development of hybrid composite using jute and E- glass mats reinforced with epoxy (LY-556) resin and HY951 hardener is carried out by M. R. Sanjay, et al. [8]. Laminates were prepared by varying the both mat layers. The test results show that hybrid composite has better mechanical properties and leads to increase of utilization of natural fibers in various applications.

II. EXPERIMENTAL PROCEDURE

Materials: The reinforcing materials used are Glass fiber and Kenaf fibers. Epoxy resin (LY 556) and Hardener (HY 951) is used as the matrix material.

Fabrication: Hand layup technique is used for the preparation of the composite. A mild steel mould of size 200 x 200 mm was used in making of the laminates. First, a wax polish is applied on the surfaces of the base plates to remove the unevenness and surface irregularities if any. Then a thin layer coating of poly vinyl alcohol (PVA) is applied with a brush and allowed to dry for few minutes. These two items will help in easy removal of the laminate from the base plates. The epoxy resin is taken along with 10% of hardener. The hardener initiates the polymerization process and accelerates the process. The kenaf and glass fibers of respective length have taken in a bowl and then they are mixed with epoxy resin by simple mechanical stirring. Then the mixture is allowed to pour in the mould and spread uniformly with the help of brush. Then the top base plate which was already applied with the wax and PVA is placed on the laid resin and a weight of about 10 kN is placed over for about 24 hours. After curing, the specimen has been taken out from the mould. The composite material has been cut in suitable dimensions for mechanical tests as per the ASTM standards.

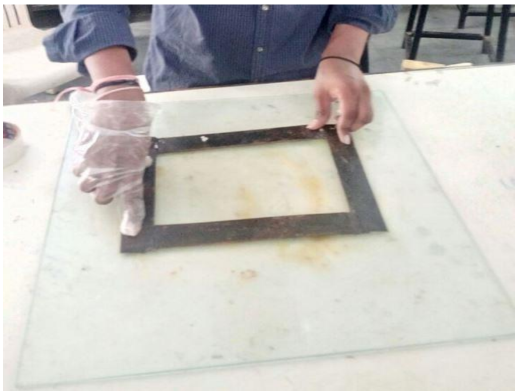

FIG.1: ADJUSTING THE MOULD ON THE GLASS PLATE

FIG. 2: LAMINATE

III. CHARACTERISATION

III.1 Mechanical Testing

III.1.1 Tensile Test: Specimens are cut from laminas on a wire jig saw machine as per ASTM D638 Standards. The standard type 4 dumbbell shaped specimens are used for testing. The dimensions of the tensile test specimen are shown in the figure 3.

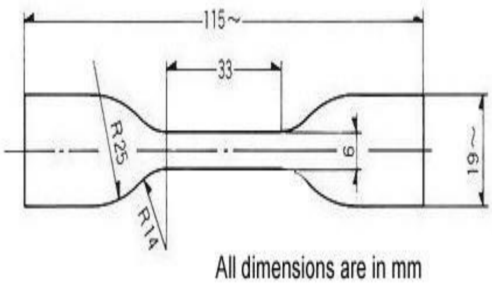

Fig.3: ASTM D638 Tensile test specimen details

Fig.4: Tensile test specimens

The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. In this test, the sample is subjected to a controlled tension until failure. Universal testing machine (Zwick / Roell Z010 10KN) was used at cross-head speed of 3mm/min. As the tensile test starts, the specimen elongates; the resistance of the specimen increases and is detected by a load cell. This load value (F) is recorded until a rupture of the specimen occurred. Instrument software provided along with the equipment to record the load value (F). The actual tensile test specimens are shown in the figure 4.

III.1.2 Flexural Test:

Flexural strength is the ability of the material to withstand bending forces applied perpendicular to its longitudinal axis. Specimens for the flexural test are cut on a jig saw machine as per the ASTM D790 standards. The flexural test specimens are shown in figure 5. The dimensions of the sample were 60.8 x 12 x 3 mm^3. As per ASTM D790, the testing machine fitted with three-point loading system applied on a supported beam was utilized. The values were taken from an average of at least 5 specimens.

Fig.5: Flexural test specimens

IV. RESULTS AND DISCUSSION

Table1: Results of Tensile and Flexural properties for different composites

Specimen	Flexural Strength (N/mm^2)	Flexural modulus (N/mm^2)	Ultimate tensile strength (N/mm^2)
4mm-UT	22.49	1987.589	13.751

4mm-T	29.5	2135.179	23.043
8mm-UT	30.46	2543.485	23.046
8mm-T	39.21	2940.554	28.446

Results of flexural behavior of different laminas are shown in table1. The flexural strength for different composites is shown in figure 6. The flexural strength is found to be highest value of 39.21 MPa for 8mm-T composite and is low for 4mm-UT composite with a value of 22.49 MPa. For 4mm treated composite lamina exhibits 31.16 % higher flexural strength than untreated lamina. For 8mm treated hybrid composite lamina exhibits 28.7 % higher flexural strength than untreated lamina.

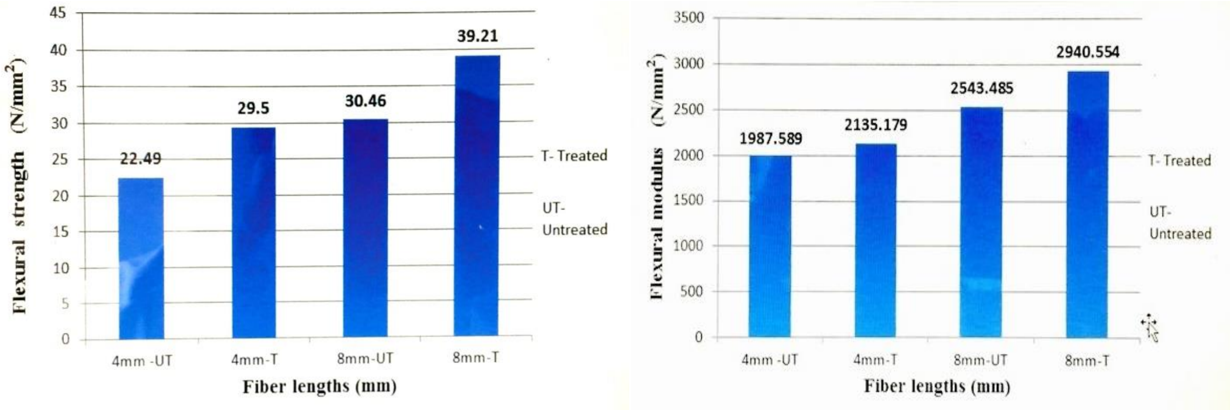

Fig.6: *Comparison of Flexural Strength and Flexural Modulus for different laminas*

The flexural modulus for different composites is shown in figure 6. The flexural modulus is found to be highest value of 2940.554 MPa for 8mm-T composite and is low for 4mm-UT composite with a value of 1987.589 MPa. For 4mm treated composite lamina exhibits 7.425 % higher flexural modulus than untreated lamina. For 8mm treated hybrid composite lamina exhibits 15.61 % higher flexural modulus than untreated lamina.

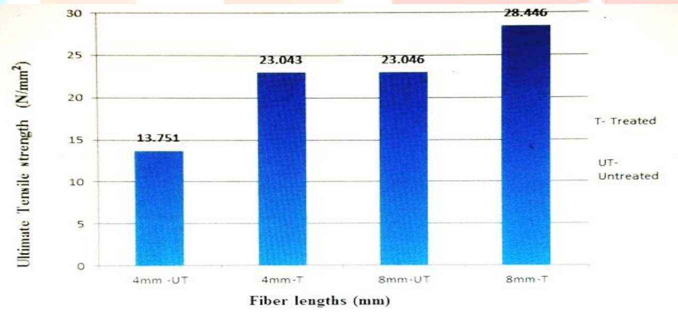

Fig-7: *Comparison of Ultimate Tensile Strength for different laminas*

Results of tensile behavior of different laminas are shown in table1.The ultimate tensile strength for different length of fibers of the hybrid composite is shown in figure 7. The ultimate tensile strength varies from 13.751 MPa to 28.446 MPa. The ultimate tensile strength achieves highest for 8mm-T composite. For 4mm treated composite lamina exhibits 67.57 % higher ultimate tensile strength than untreated lamina. For 8mm treated hybrid composite lamina exhibits 23.43 % higher ultimate tensile strength than untreated lamina.

V. CONCLUSIONS

The experimental investigation on tensile and flexural behavior of kenaf and glass fiber reinforced epoxy composite of different fiber lengths have been carried out. The mechanical behavior of the composite lead to the following conclusions: The successful fabrications of a new class of epoxy based composites reinforced with kenaf and glass fibers have been done. It has been observed from the work that type of fiber length strongly influence the properties of the composite. The flexural Strength and flexural modulus achieve a maximum value of 39.21MPa and 2940.554 MPa for 8mm treated fiber composite respectively. The lowest values are obtained for 4mm untreated fiber composite with values of 22.49 MPa and 1987.589 MPa. Among all composites developed, the ultimate tensile strength attains a maximum value of 28.446 MPa for 8mm treated fiber composite. The lowest value is 13.751 MPa, which is obtained for 4mm untreated fiber composite. This suggests that among all fiber composites developed, 8mm treated fiber composite has maximum mechanical properties. The alkalization treatment of kenaf fibers has improved the properties of the developed hybrid composite.

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