Analysis of Water absorption behaviour on Kenaf Fibre Reinforced Polymer

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***Abstract*— In recent days, the natural fibre are plays major role in replacement of metallic metals to decrease the load of components. One of the applications of natural fibre is that the marine field. We have been selected the Kenaf fibre to analyze the water absorption behaviour. A Kenaf fibre composite is formed and conducted the water immersion tests. A water absorption test has been conducted at different conditions. Also the flexural and tensile test is planned to conduct on prepared specimen. After the testing water immersed specimens are compared with dry composite specimens with their change in properties. The material is additionally analysed on the ANSYS software with the properties found from experimental work. From this analysis we have known that the kenaf fibre is a one among the best option for the purpose of wet condition field.**

***Keywords*— Kenaf fibre, mechanical properties, composite material, water absorption test.**

I. INTRODUCTION

Fibres are materials that are discrete elongated pieces or are in continuous filaments, like thread pieces.

They can even be compressed into sheets to form products like felt or paper. There are two types fibre available: first one is artificial fibre which consists of regenerated fibres and synthetic fibres and the second one is natural fibre which consists of plant and animal fibres. The invention of dyed flax fibres and wool are the evidence for humans used fibres in earlier stages itself.

The plant fibres are flax and hemp, cotton, bamboo, kenaf, coconut and jute are also mostly used.

Kenaf fibres are majorly used for aerofoils and ropes due to their high resistance and suppleness in a destructive environment.

Natural fibre utilization is significantly decreased after the World War II due to the synthetic fibres. Now, with environmental considerations like the increase in oil prices, Natural fibre usage is increased in the plastic textile, building, and automotive industries.

A. Composite Material

Composite material is composition materials and that is formed to composites. They made up of materials which have different chemical or physical properties. It made up of than one material. When it combined, the characteristics of new material will vary from the properties of materials used to form it. The finished structure of material shows each component remains separate in it. When compare to traditional materials the new material could also be preferred one due to materials that are less costly, stronger or lighter.

Typical composites include:

- Ceramic Composites
- Metal Composites
- Reinforced plastics
- Composite building materials.

Composite materials are used for structures like racer bodies, boat hulls, swimming bath panels, storage tanks, shower stalls, and bathtubs. The initial artificial composite materials were mud and straw combined to make blocks for construction.

B. Kenaf fibre

Kenaf (Hibiscus cannabinus L.) is a traditional, third world crop after wood and bamboo that's poised to be introduced as a replacement annually renewable source of commercial purpose in the so-called developed economies. Kenaf is a fibre crop growing in steamy and temperate areas.

Kenaf is associated to hibiscus, okra, and cotton due to systematics. It is a fibrous plant, consisting of an inner core fibre (75–60%), which produces inferiority pulp, and an outer bast (25–40%), which produces top-quality pulp, within the stem. Fig.1 shows the kenaf plant structure.

The plant grows to a height of 2.7 – 3.6 m and is harvested for its stalks, from which the fibre is extracted.

Mankind has skillfully made use of kenaf from ancient times, traditionally as a rope, canvas and sacking. When we are using natural lignocellulosic fibres in reinforcement matrix of fibre there is many advantages arises.

Especially, kenaf is renowned as a cellulosic source with ecological and economical advantages. Kenaf exhibits non-abrasiveness during processing, rarity, biodegradability and high specific mechanical properties.

Recently, kenaf is employed as a material to be a substitute to wood in paper and pulp industries for avoiding the demolition of forests and it is used as mats in the self-propelled industries.

Kenaf is ecofriendly for two main reasons; (a) kenaf absorbs phosphorous and nitrogen from the soil and (b) kenaf accumulates CO2 at a high rate.

Fig. 1 Kenaf plant

C. Formation of Kenaf fibre

The formation of kenaf fibre is finished with following processes fig.2.

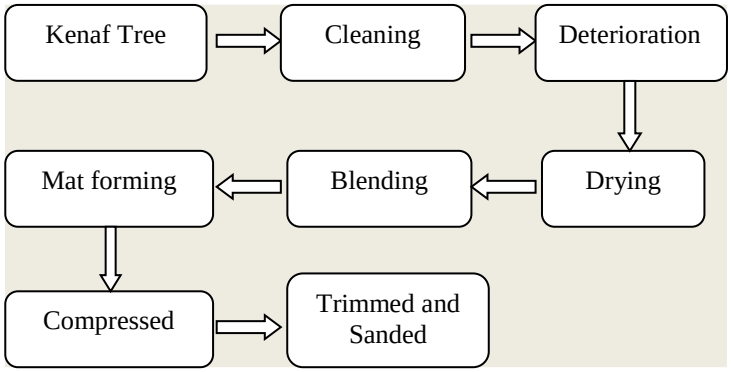

Fig. 2 Formation procedure

After finishing these processes the final fibre will look like fig. 3.

Fig. 3 Extracted kenaf fibre

II. Literature Review

Mohd Edeerozey (2007): Different concentrations of alkali treatment Kenaf fibres are studied. Chemical treatment may modify the surface, clean the surface of fibre, increase the roughness of the surface and stop moisture absorption process.

Anuar (2008): Studied the tensile and morphological properties of hybrid composite of thermoplastic reinforced with Hibiscus. The result has shown that increase in kenaf fibre content significantly reduced the modulus and tensile strength.

Shibata et al (2008): Studied the flexural modulus and Young's modulus of polymer composites formed from bamboo, kenaf and eco-friendly resin. The increase in fibre content is increases the flexural modulus.

Symington et al (2009): Studied the tensile property of kenaf, jute, abaca, flax, coir, hemp and sisal fibres for samples (1) soaked fibre, (2) 65% moisture content, (3) 90% moisture content, and (4) exposed to humidity and room temperature. It can also be concluded that the process of fibre alkalization has effect on the base strength of natural fibre, and there may be an optimum process condition if performance of the fibre in composite material form is to be maximized.

P Samivel et al (2013) This paper is to review the work carried out by using kenaf and banana fiber composite. This is due to the environmental problems and health hazard possessed by the synthetic fiber during disposal and manufacturing.

III. Proposed Methodology

This chapter gives details about which kind of method used for forming composite material and various types of methods used for testing the behaviour of prepared composite material.

The formation process is involves fibre mixed with the resin. The type of resin utilized in this material is poly propylene.

The strength of Kenaf fibre is improved with the addition of resin. The method used for forming the composite material is Hand Lay-up Process. Composite produced on this kind of formation method is uses thermal energy to extend bonding capacity of composites.

The testing which are conducted in prepared specimens are follows

Flexural test
Tensile test
Water absorption test

A. Hand Lay Up Process

This is the simplest composite formation processes. It is labor intensive and low volume method, suitable particularly for big components, like boat hulls.

Glass or roving woven or fabric material is placed manually in the mold, and the resin is poured, sprayed into glass plies. The air formed in it is detached manually with rollers or squeegees to finish the laminates structure, normal temperature epoxies are the foremost usually used matrix resins. Curing is started by a catalyst presented in the resin, which makes hardened fiber reinforced composite without the presence of any external heat.

Fig. 4 shows the process of hand layup method and its one of the simplest method to form the fibre reinforced polymer.

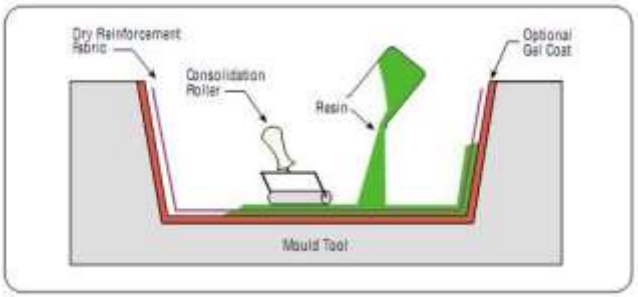

Fig. 4 Hand lay-up process

The method consists of applying these elements consecutively on top of a mold face:

- A release agent,
- A gel coat,
- A layer of thermosetting Resin,
- A layer of reinforcement

The reinforcement is completed by hand employing a brush or a roller.

This operation is repeated for every layer of reinforcement so as to get the specified Thickness of the structure.

B. Tensile Test

Tensile test is to measure the ability of an object to withstand forces that tend to drag it at a distance and to what amount the material stretches ahead of breaking.

The specimens were positioned vertically in the grips of the testing machine. The grips are then tightened firmly and evenly to avoid any slippage.

Tensile testing specimens Test are cut by saw machine as ASTM standards. .

C. Flexural Test

Flexural strength is that the capability of the material to resist bending forces applied at right angle to longitudinal axis. Sometime it's called as cross breaking strength. For finding the properties of material there are 2 methods available and are: 4-point and 3-point loading system. The beam with 3-point loading system was utilized.

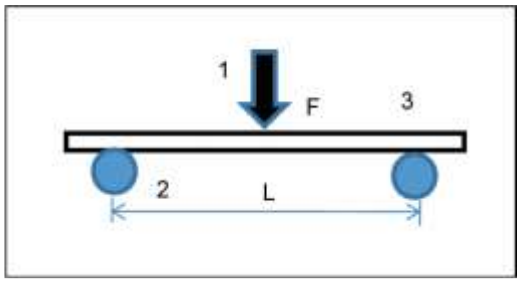

Fig. 5 Flexural testing

D. Water absorption Test

The laminates immersed in water for three weeks are gained increase in weight. When compare to fibre made with the glass it is seen that the kenaf fibre for any volume fraction, absorb extensively more water.

Additionally, the mass of kenaf laminates increase with improving volume fraction of fibre compare to the glass laminates.

IV. Results and Discussion

The results of the material are found with experimental testing and the major behaviour weight gain by the prepared material. These values are compared with the normal materials.

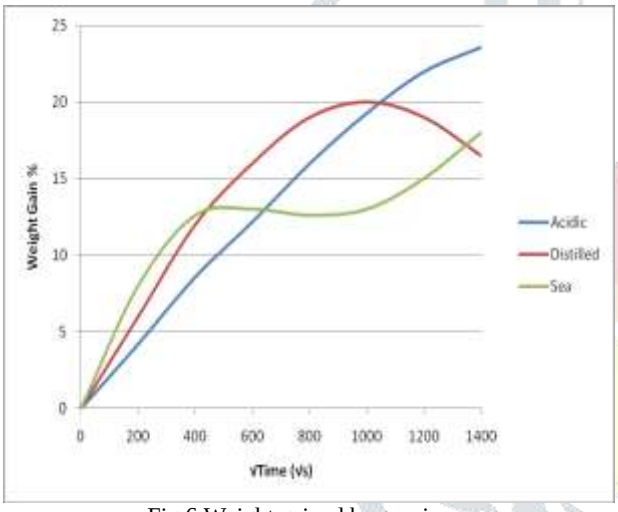

Fig.6 Weight gained by specimen

Fig.6 shows the weight gain percentage by the fibre with respect to the time. When we see the acidic solution the gain of weight by fibre will increases with its time and other water are makes increase in weight initially and decreases for some time.

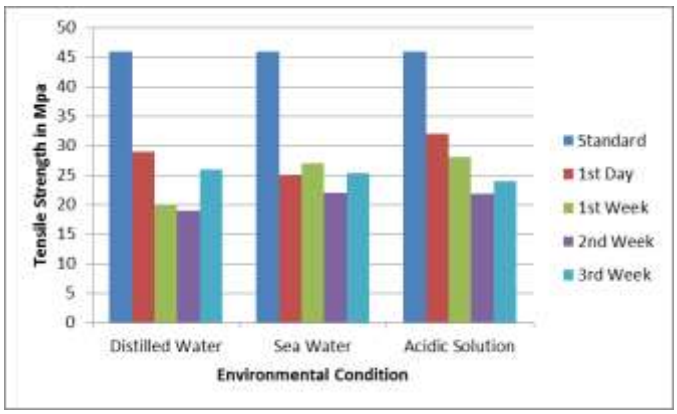

Fig.7 Tensile Strength

Fig. 7 shows the changes in tensile strength for the period of three weeks immersion of fibre into water distilled water, sea water and acidic solution.

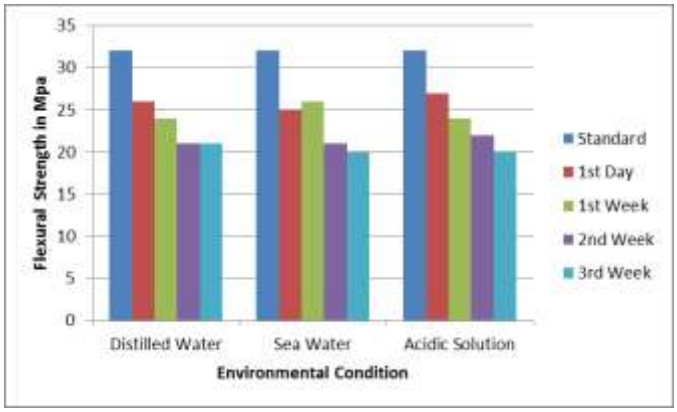

Fig.8 Flexural Strength

Fig. 8 shows the changes in flexural strength for the period of three weeks immersion of fibre into water distilled water, sea water and acidic solution.

These two graphs are shows the behaviour of material and from that we can know the kenaf fibre is a one of the better natural fibre among all kind of natural fibre. Because it have the mechanical properties at its better value and we can suggest it for its excellent properties.

The properties which are obtained from the experimental testing the specimen is modelled in ANSYS and analysed with their properties and boundary conditions.

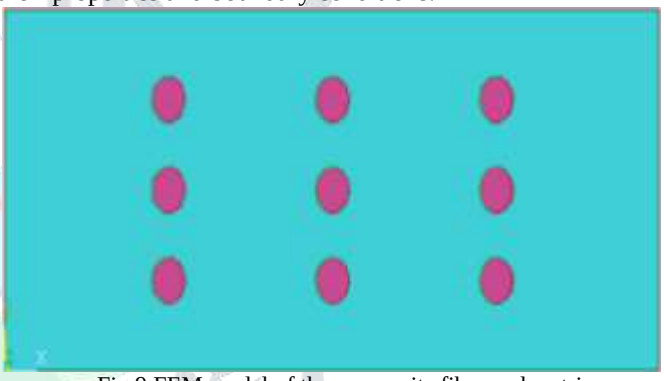

Fig.9 FEM model of the composite fiber and matrix

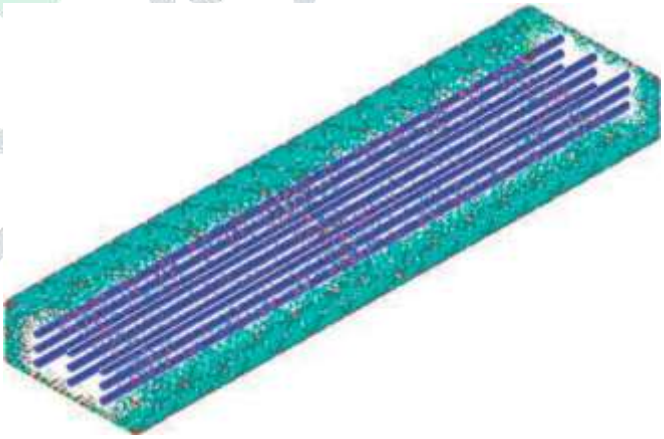

Fig.10 3D model of the composite beam

Fig. 9 and fig. 10 represnts the 2D view and 3D view of fibre model created using ANSYS software

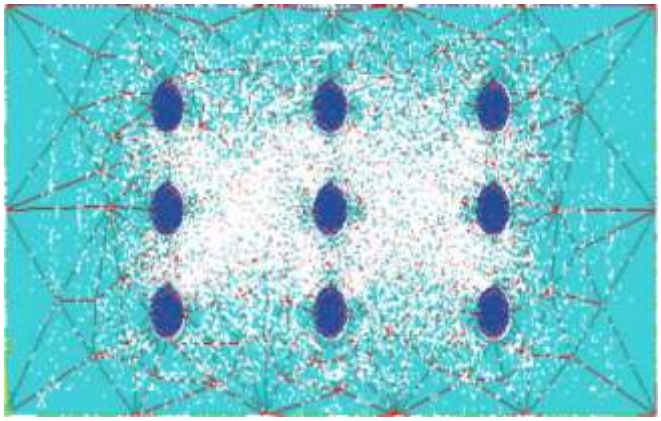

Fig.11 Meshing of fiber and matrix

The created model is meshed into small elements fig.11 shows the meshed model of the fibre element.

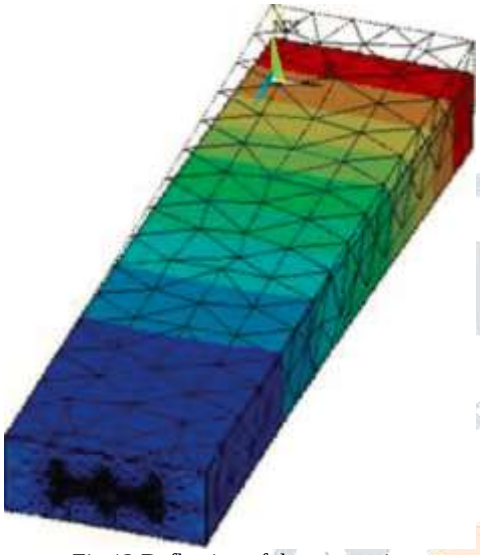

Fig.12 Deflection of the composite

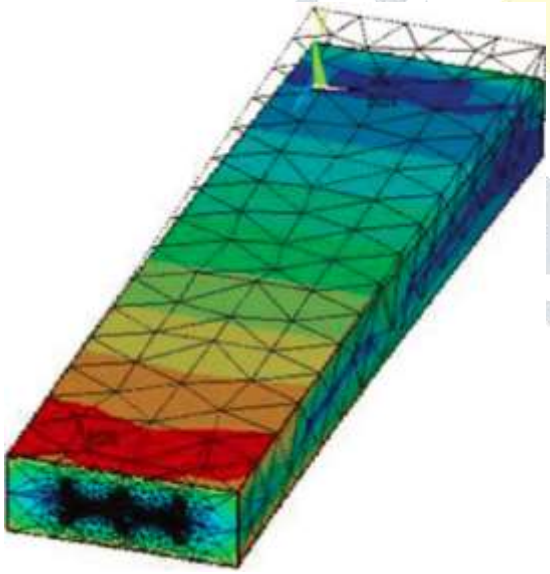

Fig.13 Stress intensity of composite

Fig.12 shows the deflection of the fibre composite at the load applied free end the deflection is higher.

Fig. 13 shows stress intensity values of composite fibre. Von missses stress and strain values are represented in fig. 14 and fig.15 the von misses stress and strain are high at the left fixed end.

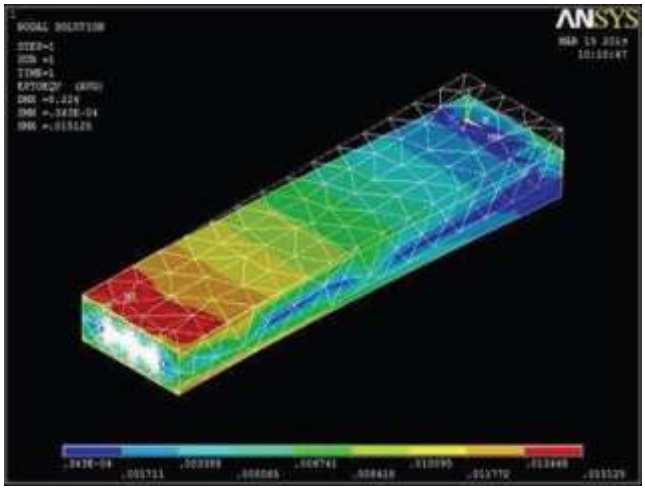

Fig.14 Von Misses stress

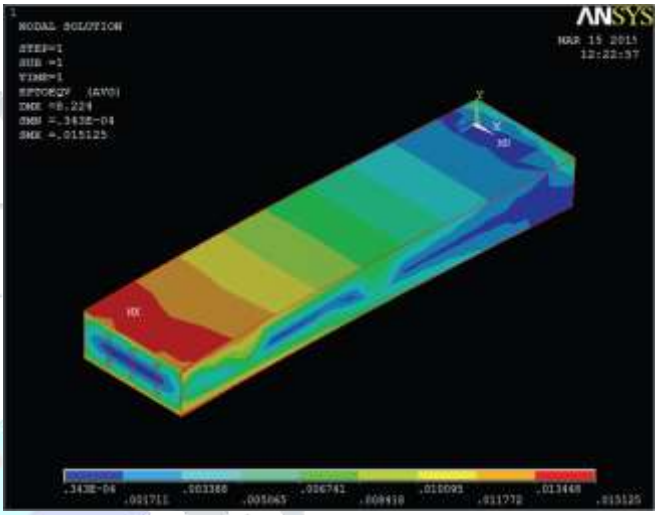

Fig.15 Von Misses strain

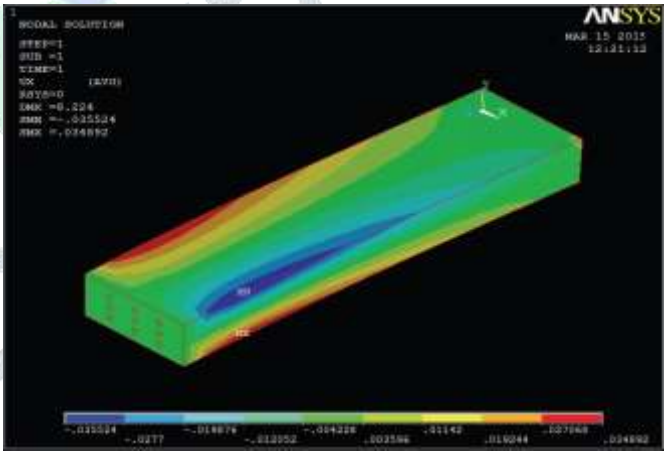

Fig.16 Nodal displacement along X direction

Fig.16 shows the nodal displacement of an object along X direction the minimum and maximum values of nodal displacement values are represented in blue and red colour respectively.

V. CONCLUSIONS

The conclusion from this project is an effect of water on the moisture content presented on the fibre reinforced.

By increasing its water resistance capacity it will be very useful in many applications.

ANSYS Results of fiber composite also gives behaviour of fiber composite such as Von Misses Stress and strain, Displacement and Deflection of modeled fiber composite. From these result we conclude that Kenaf Fiber Reinforced Polymer is one of the best option in various natural fiber for wet condition field as well as normal condition.

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