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Mechanical And Dynamic Characteristics Of Natural Fibre Composites Using Banyan Tree Aerial Roots

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Abstract **- Nowadays, the trend in the manufacturing industry is the emergence of natural fibre composites and its application in various fields of life. Earlier, all the industries were using materials which is made up of composites which was manufactured using manmade synthetic fibres. But, as the time is changing, the world is changing the materials for manufacturing composites products using natural fibres from the traditional synthetic manmade fibres. And now, we are going to manufacture a composite which is made up of natural fibres. Here, the natural fibre which we are going to use here is obtained from the aerial roots of the banyan tree. The composite made from banyan tree aerial roots is going to be tested for various mechanical properties like tensile test, surface hardness and surface roughness.**

Keywords **– extracted fibres from the aerial roots of the banyan tree, tensile strength.**

I. INTRODUCTION

In the present day scenario, there are advancements occurring in the manufacturing sector related to the change of materials mainly for reducing the weight of the component and having better material properties than the traditional manmade synthetic fibre composite materials.

Earlier, the composites components were made up of synthetic manmade fibres like carbon fibre, glass fibre, etc. But, the whole technique for the manufacturing of the composite materials is changing with the introduction of natural fibres composites. Layth Mohammed et al. on his research found that, the natural fibres have different characteristic properties based on the different kinds of fibres available in nature. Here, the natural fibres are very useful for the manufacturing of composites because of the following characteristics like biodegradable, inexpensive, high mechanical and tensile strength, inflammable properties, lower moisture absorption content and density, higher surface hardness, more service life when compared to synthetic manmade fibre composites [1].

Durga Prasada Rao et al. manufactured a natural fibre composite using banyan and peepal fibres as the main ingredient material, using the hand layup technique and the manufactured composite have been tested for its various mechanical properties such as yield strength, stiffness, hardness and flexural strength which is added with copper as an ingredient with the fibres and the results are good when compared to manmade synthetic fibre composites [2].

Milon et al, on his experimental work fabricated a natural fibre composite from the fibres extracted from the aerial roots of the Banyan tree, which has been treated in an alkaline solution. After alkaline treatment, these fibres have been manufactured using hand layup technique with epoxy resin as the binding agent and the composite has been left for curing. When the composite component is tested, it exhibited that, it is moldable to any geometry and dimension, which helps in mainly applicable for making products for automobile industry mainly with the determination of Taguchi's method for the testing of the composite. [3]

Ganapathy et al, on their experiment manufactured a natural fibre composite made from the aerial roots of the banyan tree mixed along with graphene. On testing, this composite for various mechanical tests, it has improved impact strength, hardness, flexibility and low moisture absorption capacity which is mainly achieved by the mixing of graphene, because natural fibre composites naturally have higher moisture absorption content [4].

Suraj et al, on his experiment described that he has manufactured a natural fibre composite using banyan fibres as the main ingredient. Here they have pretreated the fibres in an alkaline solution, which makes the banyan fibres stiff enough, so that the mechanical properties of the fibres improves and it also improves the bonding of the fibres with the resin forming a rigid fibre like a sandwich. Due to the treatment of the fibres, the tensile strength of the composite increases and when we see, the microscopic view of the fibres, the uniformity of the fibres are equal throughout the length of the fibre which means the composite produced will have better material properties [5].

Padmanabhan et al, on his paper describes the procedure about how to manufacture a natural fibre composite, using a banyan tree fibres along with usage of gypsum as a composition along with the resin for manufacturing the banyan fibre composite. This composite combination can be used for the manufacture of the large composites. On testing, the composite component, it exhibits various mechanical properties like high tensile strength and impact

strength, along with low moisture absorption capacity [6].

Vijaya Kumar et al, on his journal paper described about the segregation of banyan fibres as per their length. The composite made with the banyan fibres as the incorporating material and polyester as the main resin matrix, which is made according to the tensile test mould specimen size of the standard ASTM381. The composite is tested for tensile strength, where it exhibits high impact strength and tensile strength when compared to the manmade synthetic fibre composites [7].

Velmurugan et al, on his work describes about the manufacturing of hybrid sandwich type natural fibre composite using jute, kenaf fibres and fibre glass as the main ingredients for manufacturing the composite using hand layup technique. The composite is made according to the ASTM standards, and it is tested for various material properties like tensile strength, impact strength, fatigue life, flexural strength and rate of compression and it has higher strength than other natural fibre composites [8].

P. Senthil kumar et al, describes in his paper about the manufacturing of the natural fibre composites using sisal fibres and the unsaturated polyester resin as the binding agent. The composite component is manufactured according to the ASTM standards, and it is vigorously tested for various mechanical properties like tensile strength, rate of elongation and the flexural strength of the composite material were obtained [9].

Fiore et al, describes about his work on manufacturing a natural fibre composite using sisal fibre treated with sodium bicarbonate for improving the characteristics of the sisal fibre. The treatment of sodium bicarbonate helps in the release of biocomponents like hemicellulose which helps in the improvement of the fibre structure which is totally beneficial for the rearranging of the cellulose fibre to give a rigid orientation of the fibres present in the composite. This finally helps in achieving better mechanical properties of the composite [10].

Michael A. Fuqua et al, describes in his paper about various sources of natural fibres available from the plants and animals. In plants, it will have different sources like the leaves, roots, saw dust, bark, from various plants like sisal, bamboo, peepal, etc. The animal fibres sources are available from the leather and feather of the animals. So, even after the fibres are available from various sources, the fibres are need to be treated before manufacturing the composite by various manufacturing techniques like vacuum assisted resin transfer moulding, compression moulding, etc. After manufacturing the composite component, they have been tested for various mechanical properties like tensile strength, hardness, impact strength, modulus of rigidity and absorption of moisture content [11].

Juliana et al, describes in her paper about the procedure for manufacturing a natural fibre composite, where the natural fibres have been treated for various chemical treatment, which mainly helped in improving the fibre properties which is very beneficial for the binding of the fibres with the resin properly which gains us very rigid composite components, along with improved mechanical properties like high tensile strength, surface hardness and roughness, and mainly low moisture content [12].

Mei-po Ho et al, describes about the various factors to be considered while manufacturing of natural fibre composites. The factors include processing of the natural fibre, which mainly consists of the chemical treatment of the fibres for improving the quality of the fibres, which is then manufactured as composite using various manufacturing techniques using injection moulding, resin transfer moulding technique. After the composite is manufactured, the composite is tested for various mechanical properties like impact strength, absorption of moisture content, tensile strength [13].

Arun Prasath et al, describes in his paper about the manufacturing of a natural fibre composite, where the fibres are extracted and treated in chemical solution and then, they are made into a composite components and they have tested using FEA techniques which mainly helps in determining the avoidance of the structural deformation of the fibres very accurately during testing of the composite for various mechanical properties like tensile test, compression test [14].

Karthik et al, describes his experiment about how to manufacture a natural fibre composite using banyan tree seeds. The seeds of the banyan tree has been cleaned and dried in order to lose moisture content. Then, the seeds have been mixed with the resin which is an unsaturated polyester resin which is finally used to make the composite component. After that, this composite component is tested for various mechanical properties like maximum impact strength, rate of elongation and flexural strength [15].

Weiwei et al, describes about how they manufactured a natural fibre composite made from rubber and the result for the surface treatment of the composite with potassium permanganate on the composite. It mainly helped in improving the fibre strength, which on testing gave improved tensile strength, low chance of failure of the composite on service and better bonding of the fibres with the resin in order to form a rigid matrix structure [16].

M.Saravanan et al, describes in his paper about various requirements of the raw materials required

for manufacturing of the natural fibre composites and testing of the composites to find the mechanical properties of the composites. Here, they used banyan tree fibres as the reinforcing material for the manufacturing of the natural fibre composites as per the ASTM standards using the Hand Layup Method. Then, they have been tested for various mechanical properties like tensile strength, flexural strength and the impact strength of the composite which gave better results than the synthetic manmade fibre composites [17].

Pothamsetty Kasi et al, describes about the manufacturing of the fibre reinforced composites using hand layup technique. The material they used as fibres is the jute fibres. They made jute fibre composites using Hand Layup Technique and it has been tested for various material properties like tensile strength and impact strength, where it performed better with respect to the weight ratio of the plant fibres [18].

Vigneshwaran et al, describes in his paper about various improvements obtained on continuous research in the field of manufacturing of natural fibre composites, and when tested for their material properties, they gave very astonishing results like, they are biodegradable, easy to manufacture, high tensile strength, fatigue strength, impact strength, chemically stable, and low moisture absorption capacity [19].

Feng Zhou et al, describes about their experiment of manufacturing of natural fibre composites using sisal fibres which is treated in silane solution. The sisal fibres when treated in silane solution, it totally changes the fibre characteristics. It mainly helped in changing the biodegradation characteristics of the silane fibres. And when tested, the composite exhibited light weight, chemical and thermal resistance of the natural fibre reinforced composite [20].

Thus, we got an idea of the various types of natural fibres manufactured as composites and their characteristics based on their test results.

II. METHODOLOGY

Now, after reading many journal papers, we got an idea of manufacturing natural fibre reinforced composite, using the extracted fibre from the aerial roots of the banyan tree as the main fibre material.

The natural fibre composite is going to be manufactured using epoxy resin through Hand Layup Technique.

The epoxy resin is a synthetic resin which mainly helps in preventing the degradation of the banyan fibres.

The banyan fibres are extracted from the aerial roots of the banyan which has been shown in the figure 2.1 (which has been taken from the reference paper [3]).

Figure 2.1 Process Of Extraction Of Fibre From The Banyan Tree Aerial Roots

The figure 2.1 explains about the extraction of banyan fibres in a step by step process.

The extracted fibre is treated by dipping the extracted banyan fibres in the silane solution treatment which mainly helps in strengthening the fibre structure for gaining a desirable mechanical properties which is mainly obtained only by proper binding and fusion of the fibres along with the epoxy resin in order to form a rigid composite component.

The extracted fibres from the aerial roots of the banyan tree is shown in the figure 2.2 (which has been taken from the reference paper [2]).

Figure 2.2 Extracted Fibre From The Aerial Roots Of The Banyan Tree

After the fibres have been treated in the silane solution, the fibres have dried and knit into the form of a mat to make it as a fabric mat.

And the most important thing is to be noted here, is that we are going to use calcium oxide as an additive with the epoxy resin.

The calcium oxide is obtained by processing the calcium carbonate. The calcium carbonate is obtained from the sea shell. The sea shell is crushed and

grinded into a fine powder, and the powder is heated at 700ºC to obtain calcium oxide as the final product.
The calcium oxide helps in gaining the fibre particles a finishing characteristic when the component is being manufactured.
Finally the calcium oxide obtained is added to the epoxy resin in different percentages of weight ratios, in order to get different compositions of the composite component to be manufactured.
The different compositions of the manufactured composite component is tested for various mechanical properties like tensile strength, impact strength, and the flexural strength of the composite component. And the results are obtained to understand the stability and the characteristics of the different combinations of the composite component.
The resin we are going to use here is an epoxy resin (which has been taken from the reference paper [5].

Figure 2.3 Resin and Hardener As The Main Component For The Preparation Of The Epoxy Resin

As shown in Figure 2.3, the white transparent liquid is the resin and the yellow colour liquid is the hardener.
The hardener mainly helps in fast curing action of the resin.
The resin and hardener is generally mixed with each other in the ratio of 2:1 as prescribed in the resin mixture composition.
The resin and hardener is mixed thoroughly to avoid formation of air bubbles in resin mixture.
Now, all the components required for the manufacturing of the composite component is present.
The composite component is manufactured using the hand layup technique.
First, the resin is poured on the mould of the ASTM size and it is evenly spread to all the sides of the mould.
Then, the fibre mat is placed over the resin and it is evenly spread for proper binding of the resin along with the fibre.
Next, the resin is poured over the fibre and spread evenly all over the fibre for proper binding of the fibre with the resin.
Again, place the fibre over the resin evenly for proper binding of the resin with the fibre.
And again pour the resin over the fibre, and this is a continuous process till 3 to 4 layers of the fibres is placed over the resin and finally the resin is poured on the fibre to complete the manufacturing of the composite component.
This process, is applicable for different compositions of the composite component to be manufactured.
After the composite component has been manufactured, it has been tested for various mechanical properties like tensile strength, impact strength, flexural strength and compression strength.

III. RESULT

This project mainly focuses on the manufacturing of the natural fibre composites using the aerial roots of the banyan tree. The extracted fibres from the banyan tree aerial roots, which is mainly as the main ingredient for the manufacturing of the natural fibre composite. The extracted fibres here are strengthened through the chemical treatments in order to make the fibres stiff enough to make the fibre mat for manufacturing the composite component. The treated fibres make the composite component strong, that on testing the natural fibre composite for various mechanical properties like impact strength, tensile strength, flexural strength, compression strength and the surface hardness. The material of the natural fibre composite mainly helps it perform better than other synthetic manmade fibre composites.

IV. CONCLUSION

Here, we are going to manufacture a natural fibre composite using the extracted fibres from the aerial roots of the banyan tree. The fibres which are extracted from the aerial roots of the banyan tree is treated for chemical treatment using silane solution which mainly has an added advantage of increasing the characteristics of the natural fibres which, mainly determines when the composite component made from the treated natural fibres is manufactured and being tested for various compositions of the composite component.

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