Integration of Sugarcane Bagasse and Waste Plastic Materials for Aeronautical Applications

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Abstract - *The main objective of this project is to produce a composite using waste and non-biodegradable materials which can be utilized for many applications such as parcel shelves, cabin linings, electrical appliances, window covers etc. Due to high fuel prices, the operation management cost of the aircraft industry has gone high. So, to minimize the cost of management by reducing weight of aircraft components, we can use low-cost composite material developed by using waste and non-biodegradable materials. This work describes the hand lay-up process of the biodegradable & non-biodegradable composite using bagasse fibers, plastic fibers, and the polymer matrix, with different composition of fiber matrix combination and different testing such as tensile, compressive, impact, hardness and vibration testing has been conducted to study the characteristics of developed composite material. As it is an eco-friendly approach, this will in turn help us to clean our earth to some extent. This obtained product has good strength to weight ratio, tensile strength, compressive strength, Impact strength, electric resistance, low cost & ease of fabrication etc.*

***Keywords**: Hand-Layup, Polymer Matrix, Bagasse Fibre, Plastic Fibre*

I INTRODUCTION

When two or more materials are combined on a macroscopic level without mutually soluble, a composite material can be produced. The material of the reinforcing phase can be in the form of fibers, particles, or flakes and matrix phase materials are generally continuous [1]. Many composite plastic products are produced by hand laying. A few examples of the methods used are boats, portable toilets, picnic tables, car bodies, hard shell covers and airbags and indoors. Traditional building materials include aluminum, steel, and titanium to replace a wide range of composites such as fiberglass [2]. The operational benefits associated with the reduction in aircraft structure have been a major impetus for the development of a combination of military aircraft. In aircraft construction, most types of composites are those made of fiberglass and carbon fiber [3].

There are many fibres that can be used in the preparation of the composites that too when it comes to the agricultural sector almost every substance or the material that is produced in the farm land can be utilized by cleaning them up and based on its desirable qualities we can select the type of fibre we need to prepare the composite with ,there are many fibres available in the farms such as sisal, jute, kemp, bamboo, banana, cotton ,hemp and so on and also there are many waste materials that are being produced in the urban places such as glass fibres, plastic materials etc [4].

This helps us and gives us an opportunity in preparing new composites by reducing these wastes which gets deposited into the environment and making it bad of living

organisms, and many fibres are strong due to its biological characteristics, so these are very useful in the preparation of the composite materials [5].

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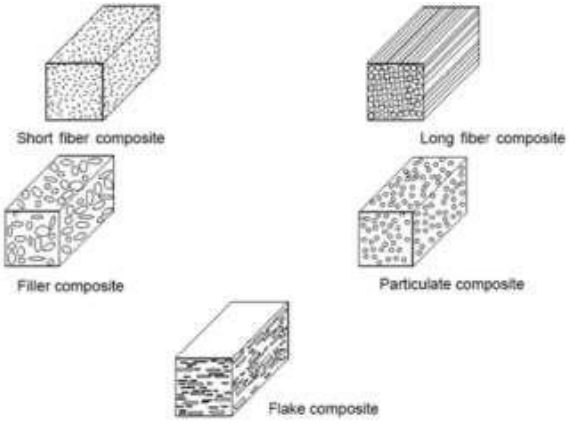


Figure 1: Types of Composite Matrixes

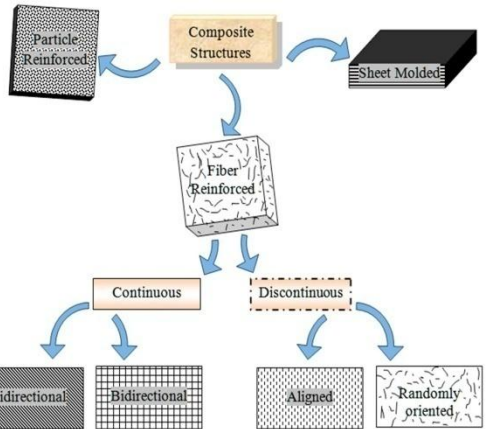
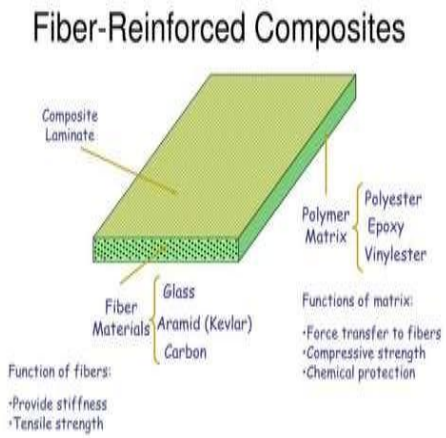


Figure 2: Composite Structure



High fuel prices have significantly affected the operations of the aircraft industry,the use of composite materials can be used in commercial aircrafts to save money by using these materials

Plastic contributes about 16%of solid waste in our country and 50-80% of waste littering in beaches, only 1/3rd of the plastic goes in disposable products, the major efforts continue to develop complete biodegradable

Figure 3: Fiber Reinforced Composite Structure

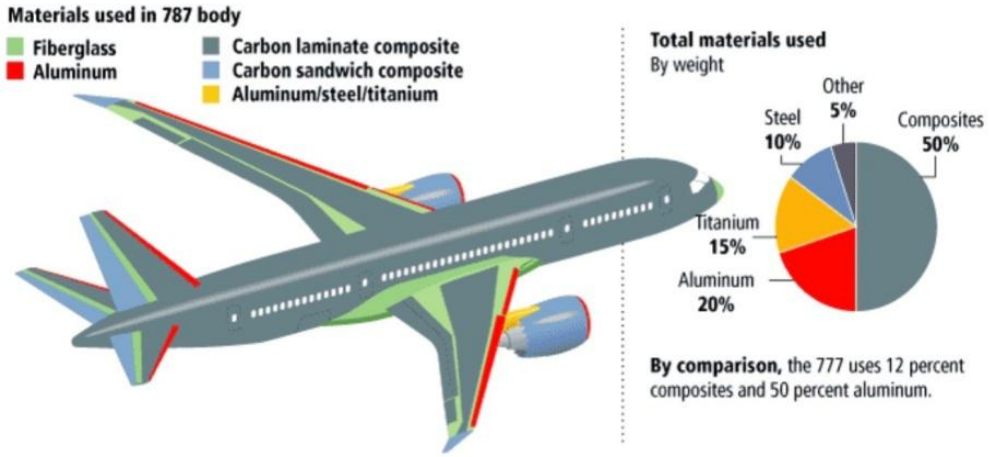


Figure 4: Composition of Aircraft Materials

II METHODOLOGY

The waste plastic material is collected from the trashes of shops, the material is cleaned so that the is no other material except plastic is present in it. Then the cleaned plastic is placed in the set up to cut it into longer and thin material. Here we have used waste plastic bottle to extract plastic material for the preparation of the composite material [7]

Waste Plastic

Sugarcane Fiber

For the extraction of sugarcane fibre first we must take the sugar cane and extract all the juices from it. The bagasse obtained from it must be dried for 24 hours. Alkaline solution treatment is done on the sugarcane fibre so that all the sugar content from it is eliminated. After extracting the fibre, it is left to dry in sun for 24 hours, then the sugar cane fibre is obtained [8].

Drying of Sugarcane Fiber Soaking in Alkaline Solution

Collecting the Fibres after these Processes

Plastic Fibre Mat

Sugar cane waste, also known as bagasse, is a dry, pulpy material that remains after extracting juice.

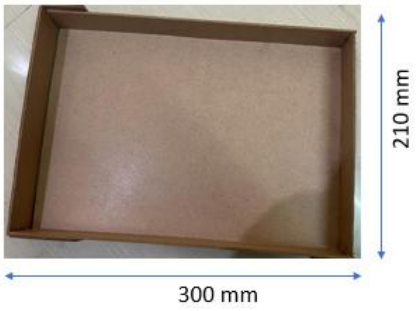
As shown above are the figures, the procedure is as follows:

- To fabricate the composite, firstly we must collect Bagasse & washed it thoroughly so that no sugar is left out.
- After proper washing is done with the alkali solution, we have dried the Bagasse nearly a day to remove any moisture present in it.
- Then on the other side we have collected waste plastic bottles and we must clean them thoroughly.
- Then these fibres material and the plastic are made in a mat form so that the fibres are evenly distributed.
- Then it is laid on the waxed surface of the plate then the matrix material (epoxy resin) is poured on it.
- To get the desired thickness the glass fibres layers are again laid on it.
- To spread the epoxy in every place evenly the roller is used.
- Then the material is compressed, and the final product is obtained.
- Thus, the strength, resistance and durability tests can be conducted on it.

Properties	Bagasse Fibers	Plastic Fibers
Density	0.616 g/cm^3 616 kg/m^3	0.92 g/cm^3 940 kg/m^3
Tensile strength	2.29Mpa	60-85Mpa
Youngs modulus	4.526Gpa	0
Composite strength	89.9Mpa	2.7Gpa

III EXPERIMENTAL DETAILS

Mold Preparation: We have used MDF sheets which are made of Pine MDF wood. This board do not expand or contract like a normal wood. The square ply is cut into rectangular shape so that the side walls are being created to hold the resin mixture in it and give the composite the rectangular shape, the cover is also made to close the mild without letting the air gap using the same board [9].



Epoxy & Release Agent

Preparation of the Composite Material

After extracting the fibres from the sugarcane bagasse they are made in the form of mat. This mat is then used for the binding of the epoxy with other substances , now the resin and hardener are taken in the ratio of 3:1 and both are mixed In the 1 litre measuring jar by using a glass rod [10] .Then the mould which has been dried after applying the releasing agent is taken , now the mixture is poured into the mould by using the paint brush the mixture is evenly spread across the mould now the glass fibres are laid first later by using the roller the liquid is spread across the fibres evenly now the bagasse mat is laid onto it then one more layer of the liquid is poured and the roller is used again to spread the liquid evenly , finally last layer is the glass fibre this is kept on the fibres and the remaining liquid is poured and by using roller the epoxy is spread across evenly [6].

The images of the procedure are as shown below.

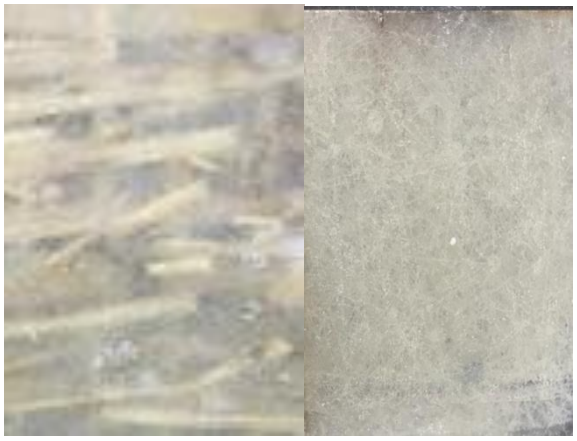
Wax Coated to the Mould

Wax Coated on the Top Cover

First the Epoxy Mixture is Poured which is Mixed in the Ratio of 1:3

Glass Fiber Sheet Placed Over Epoxy

Rolling is done to Remove Air Trapped Inside & Spreading Epoxy



Bagasse and Glass Fibers Successive Layers to Finish the Composite

The waxed layers ensured the correct output without any delamination's and damages in the composite, after 24 hrs of curing time we removed the composite from the mould and the outcome is as shown in these pictures. The final composite is of the dimensions (280*210*8) cubic mm.

Composition of the sugarcane composite material is as follows:

- Sugarcane fibers(bagasse): 16%
- Glass fiber sheet: 17%
- Resin: 50%
- Hardener: 17%

Now the preparation of the second composite is also in the same manner of how the first composite was prepared, we are using hand lay-up process for the manufacturing of the waste plastic composite also due to its easy handling processes [8].

To produce this composite, we must make a separate mould as the size of this plastic mat is smaller than the bagasse mat so that we can use less resin mixture for this composite.

There will be 3 layers of fibres used in the preparation of this composite which consists of glass fibre sheet and plastic mat [10].

For the preparation of resin mixture, we must follow the following steps:

- Mixing ratio 3:1
- Working time 120 mins
- Curing time 24hrs

Once all the manufacturing procedures are done next, we will move on to check the ability of the composite which we have obtained these includes destructive and non-destructive types of testings [14].

Composition of composite using waste plastic material:

- Waste plastic: 11%
- Glass fiber: 21%
- Resin: 51%
- Hardener: 17%

IV RESULTS AND DISCUSSION

Various testing methods have been performed on this material they are as follows:

- UTM Testing
- Impact Testing
- Hardness Testing
- Vibration Testing

Results of Test Specimens

UTM Test Results

Bagasse composite tensile test
Length = 300mm
Gauge length = 170mm
Width=20mm
Thickness = 8mm

Bagasse composite compression test
Length = 300mm
Gauge length = 170mm
Width=20mm
Thickness = 8mm

Plastic composite tensile test
Length = 300mm
Gauge length = 170mm
Width = 20mm
Thickness = 6mm

Plastic composite compression test
Length = 300mm
Gauge length = 170mm
Width = 20mm
Thickness = 6mm

Table UTM Test Results

Sample no	Ultimate Load	Displacement
1	1.10KN	2.80mm
2	1.48KN	2.80mm
3	1.46KN	2.40mm
4	1.22KN	2.50mm

Hardness Test Results

Figure Sugarcane bagasse fibers (50mm*50mm)
Load – scale value
50kgf – c20- 160 microns
100kgf – c80- 40 microns
150kgf – c40- 120 microns

Figure Plastic fibers (50mm*50mm)
Load – scale value
50kgf-c30-160 microns
100kgf-c25-150 microns
150kgf-c20-140 microns

Izod Test Results

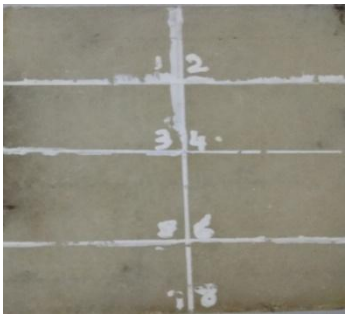
Plastic Composite

Sugarcane Composite

Izod Test Result

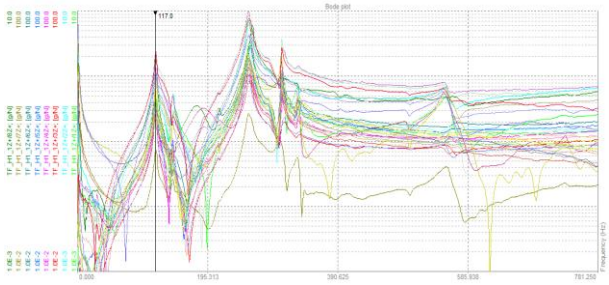
Material	Length In mm	Depth in mm	Cross section area in mm^2	Impact energy absorbed	Impact strength=U/A (Nm/mm^2)
Sugarcane	65	4	80	3j	0.0375
Plastic	65	4	80	4j	0.05

Vibration Test Result: Plastic Composite

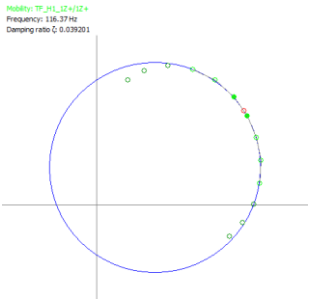


Plastic Test Specimen

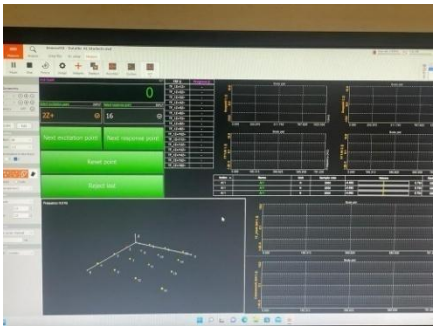
Testing Assembly



Vibration Test Result of Plastic Composite

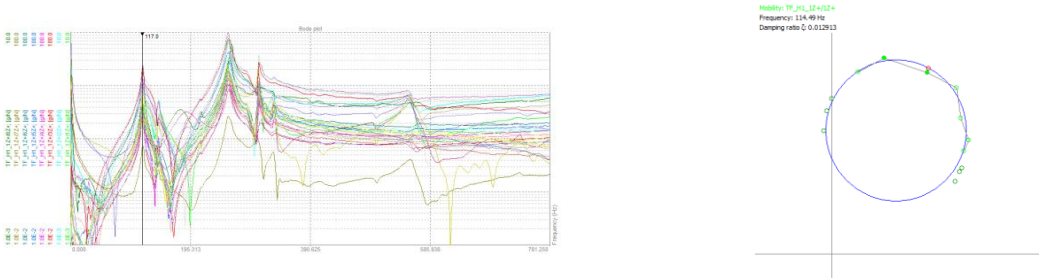


Mobility of Plastic Composite

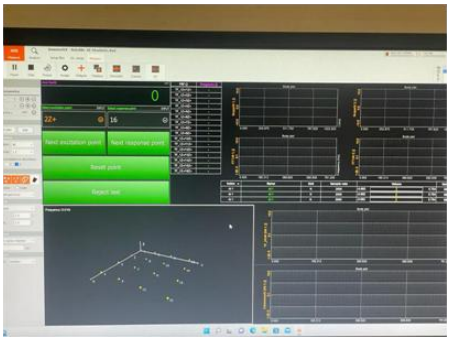


Software Setup for Plastic Composite

Bagasse Composite Test Specimen



Vibration Test Result of Bagasse Composite



Mobility of Bagasse Composite & Software Set-Up

V CONCLUSION

From this experiments results, it can be concluded that fiber and its orientation have major effect on its mechanical properties of developed composites. Alkali Treated bagasse fibers has shown improved properties. Due to desirable properties observed in the bagasse & plastic fibers, these composites have very good potential use in the various sectors like construction, automotive, aviation, machinery based on its mechanical properties such as tensile strength, hardness, impact strength and flexural strength. The fabrication of bagasse & plastic fiber-based epoxy composites with different fiber orientation can be done by hand lay-up process. Such bio-composite are Eco-Friendly and can be used as a replacement of harmful plastics in interior parts of Passenger Car, aircraft structure, wing boxes, lavatory doors, seat covers of the aircraft, Decorative Parts and for furniture purpose.

In our country the natural fibers are abundantly found in all corners so we can utilize these resources to produce many such useful materials. This composite will also help us fight against global warming, waste management. This helps us to recycle the plastic and bring it into desired shape and size, make them into usable and long-lasting application. By buying natural fibers from farmers, it helps the farmers economically too.

The outcomes of this project can be used in automation and aeronautical industries to produce parts since they can be brought into any desired shape and be used in even simple components, by using this composite we can not only get operation costs of the aero industry down but also is helpful in reducing the pollution causing factors such as plastic disposal in the open space, to create a better future we must adapt to the suitable materials. There are opportunities in future to develop these composites or even hybrid composites using natural fibers can be produced.

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