

# Properties of Aegle Marmelos Composite Fiber

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**ABSTRACT:** Composites play an important role in today real life with wide applications in aerospace, infrastructure, military and so on. Different types of composite have different characteristics depending on which selection is made in real world. Among those different composites, the natural fiber-reinforced polymer composite is rapidly growing both in terms of their industrial applications and fundamental research as they are cheap and eco friendly. These natural fiber-reinforced polymer composites are renewable and completely or partially recyclable and biodegradable. Due to the easy availability of these composites, demand for these is more in many sectors. Natural fiber appear to be an alternative to synthetic fiber in transportation such as automobiles, railway coaches and aerospace. Other applications include military, building, packaging, consumer products and construction industries for ceiling paneling, partition boards. In this paper, Aegle Marmelos is taken as natural fiber for analyzing. This paper mainly focuses on the classification of different natural fibers reinforced polymer composite and the treatment of Aegle Marmelos composite fiber with various chemicals. This paper also focuses on evaluation of the impact strength of Aegle Marmelos fiber composites using Izod Impact test.

**KEYWORDS:** Composite, Natural fiber, Chemical treatment, Impact strength, resin.

## I. INTRODUCTION

Composite is a combination of two or more materials (mixed and bonded) on a macroscopic scale. Generally, a composite material is composed of reinforcement (fibers, particles, flakes, and/or fillers) embedded in a matrix (polymers, metals, or ceramics). The matrix holds the reinforcement to form the desired shape while the reinforcement improves the overall mechanical properties of the matrix. When designed properly, the new combined material exhibits better strength than would each individual material.

Composites consist of one or more discontinuous phases embedded in a continuous phase. The discontinuous phase is usually harder and stronger than the continuous phase and is called the 'reinforcement' or 'reinforcing material', whereas the continuous phase is termed as the 'matrix'. Composites are classified into different types namely fibrous and particulate composites. The classification of composites is as shown in fig 1.

Natural fiber composites include coir, jute, baggase, cotton, bamboo, hemp. Natural fibers come from plants. There are many features of Natural fibers such as eco-friendly; lightweight, strong, renewable, cheap and biodegradable which make them to attract researchers to invent new composites. In general, many composites consist of a bulk material (the 'matrix') and a reinforcement of some kind added primarily to increase the strength and stiffness of the matrix. The natural fibers can be used to reinforce both thermosetting and thermoplastic matrices. Thermosetting resins such as epoxy, polyester, polyurethane, phenolic are commonly used composites requiring higher performance applications. They provide sufficient mechanical properties in particular stiffness and strength at acceptably low price levels. These composites are gaining importance due to their non-carcinogenic and bio-degradable nature. Natural fiber composites are very cost effective material especially in building and construction, packaging, automobile and railway coach

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interiors and storage devices. However, the main disadvantages of natural fiber composite are the relative high moisture absorption. Therefore, chemical treatments are done so as to modify the fiber surface properties.

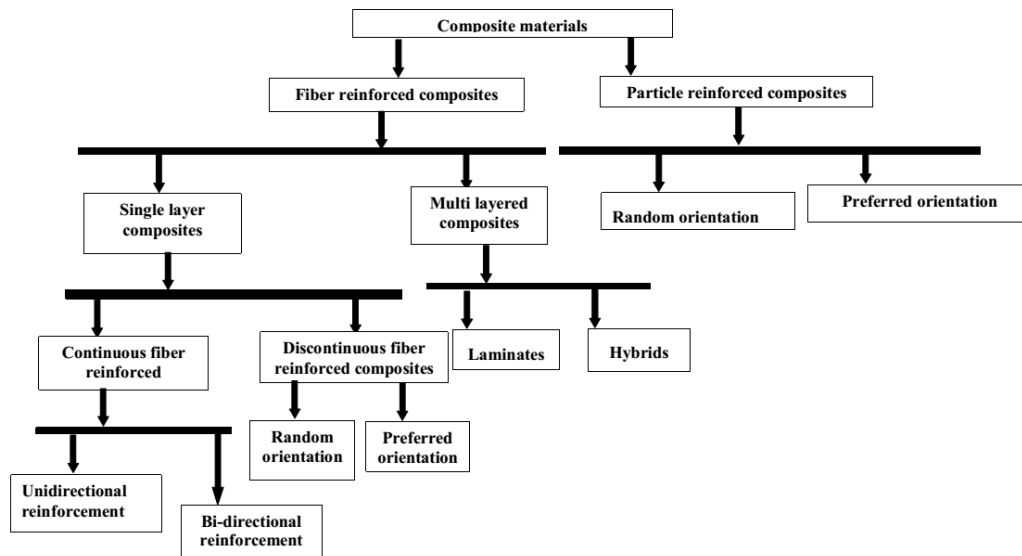


Fig.1 classification of composites

## II. CLASSIFICATION OF NATURAL FIBERS

Natural fibers are easily available at very low cost. The term “natural fiber” covers a broad range of vegetable, animal and mineral fibers. However in the composite industry, it is usually refers to wood fiber and agro based bast, leaf, seed, and stem fibers. These fibers often contribute greatly to the structural performance of plant and, when used in plastic composites, can provide significant reinforcement.

Natural fibers include those made from plant, animal and mineral sources. Natural fibers can be classified according to their origin as animal fiber, mineral fiber, and plant fiber. Fig.2 shows the classification of natural fibers.

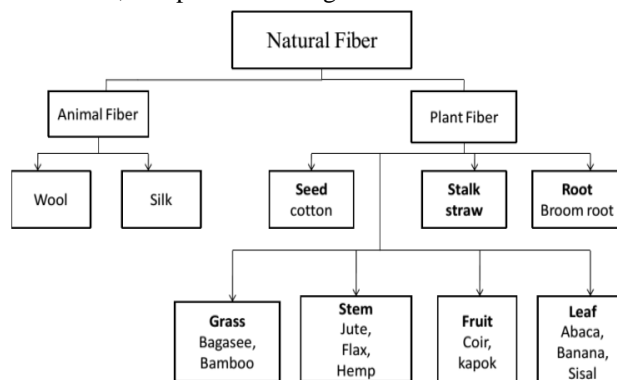


Fig.2 classification of natural fiber

## III. PROPERTIES OF NATURAL FIBER COMPOSITES

The constituent of any natural fiber vary with origin, area of production, variety and maturation of plant. The major constituent of a fully developed natural fiber cell walls are cellulose, hemicellulose, lignin and pectin. These hydroxyl-

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containing polymers are distributed throughout the fiber wall. composite properties depend mainly on the single fiber chemical composition (Cellulose, hemicelluloses, lignin, pectin, waxes, water content and other minors) according to grooving (soil features, climate, aging conditions) and extraction/ processing methods conditions. Grooving conditions is recognized as the most influent parameter for the variability of mechanical properties of the fibers. The chemical composition of several natural fibers is summarized in Table I.

TABLE I  
CHEMICAL COMPOSITE OF NATURAL FIBERS

Fiber	Cellulose %	Lignin %	Diameter (µm)	Hemicelluloses %	Elongation %
Coir	37	42	100-450	0.15	47
Banana	64	5	50-250	6-19	3.7
Sisal	70	12	50-200	10-14	5.1
Pineapple	85	12	20-80	16-19	2.8
Jute	71	13	15.9-20.7	13-20	3.0

## IV. NATURAL FIBER REINFORCE COMPOSITE

The recent area of research is concentrated on plant fiber composites, which are blended with resins. The natural fiber composites are seen as potential materials for many engineering applications. Here, the natural fiber taken was Aegle marmelos as shown in fig. 3, which is available in Indian environmental conditions. Aegle marmelos, locally called, as 'Bilva' or 'Maredu' is one such natural resource whose potential as fiber reinforcement in polymer composite has not been explored in complete.



Fig.3 Aegle Marmelos

Aegle marmelos, commonly known as bael, Bengal quince, golden apple, stone apple, wood apple, bili is a species of tree native to India. large grapefruit or pomelo, and some are even larger. The shell is so hard it must be cracked with a hammer or machete.

Besides the wide medicinal utility the plant and its certain parts (leaves and fruits) are of religious importance since the tree is regarded as one of the sacred trees of Indian heritage. Aegeline (N-[2-hydroxy-2(4-methoxyphenyl) ethyl]-3-phenyl-2-propenamide) is a known constituent of the bael leaf and consumed as a dietary supplement for a variety of purposes.

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## V. PREPARATION OF COMPOSITES

A number of Aegle Marmelos fibers were collected from its tree. A glass mould of dimensions 200mm x 200mm was taken in order to prepare composite. Epoxy was taken as resin and collected Aegle Marmelos fibres as reinforcement. The first step is to cut fibers in such a way that the fibers fit in the length of glass mould and the amount of fibers taken was 10grams in weight. Those cut fibers were placed in the mould and in the meanwhile, epoxy was taken in a flask and is stirred continuously to make it free to pour. After placing the fibers according to the required orientation, epoxy was poured into the flask slowly according. Then, a OHP sheet was placed on the mould and rolled with a round stick on the sheet so that excess epoxy comes out of mould. Care should be taken while rolling in order to avoid formation of cavitation. After rolling process is completed, some weight is placed on the mould so that fibers will not move and was kept alone for about 24 hours. To remove the prepared composite in the mould, it was placed in microoven at temperature for about 20 minutes. After taking out mould from Oven, the composite from the mould was removed carefully without damage. Now the composite was cut into 10 pieces of dimensions 5mm x 3mm each. The weights of composite pieces in grams were noted down for further use and are shown in below table II.

TABLE II  
WEIGHTS BEFORE CHEMICAL TESTING

Name of fiber	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5	Sample 6	Sample 7	Sample 8	Sample 9	Sample 10
Aegle marmelos	0.15	0.18	0.17	0.15	0.22	0.22	0.22	0.12	0.21	0.16

## VI. CHEMICAL TREATMENT

Once the composites of required shape and length are available, these were undergone chemical treatment with various chemicals to identify the reaction of composites with chemicals. A total of ten different chemicals were used for testing. These chemicals were taken in different vessels individually and the composites of different weights were immersed in those chemicals one by one and kept alone for 24 hours and weights were noted for comparison. The weights in grams obtained for different samples after chemical treatment were tabulated as shown below in table III.

TABLE III  
WEIGHTS AFTER CHEMICAL TESTING

Composition	Sample number taken	Weight after chemical treatment (grams)
40% Nitric acid	1	0.17
10% HCL acid	2	0.18
8% Acetic acid	3	0.21
10% Sodium hydroxide	4	0.21
20% Sodium carbonate	5	0.24
10% Ammonium hydroxide	6	0.23
Benzene	7	0.29
Towline	8	0.14
Carbon tetra chloride	9	0.26
Water	10	0.22

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## VII. IMPACT TEST

Four samples of Aegle Marmelos composite fibers each of dimensions 67.5mm x 3mm x 10mm with weight% 5, 10, 15, 20 grams were taken to find the impact strength. The samples taken were fabricated in straight orientation as mentioned above in preparation of composites.

After fabrication, the test specimens with notch angle  $0.5^{\circ}$  were subjected to impact test as per ASTM standard. The standards followed are ASTM D256 for impact test. Test was carried out using Kaiser Izod impact machine as shown in below fig. 4.



Fig. 4 Kaiser Izod Impact Machine

The machine specifications are as follows:

Display	: Digital Indicating Unit
Scale range	: 2.0, 4.0, 7.5, 15.0, 25.0 Joules
Hammers	: Two
Power supply	: 230V AC, 50 Hz, Single Phase

The specimens taken were shown in below fig 5. These specimens are of dimensions 67.5mm x 3mm x 10mm with weight% 5, 10, 15, 20 grams.



Fig. 5 Aegle Marmelos composite fiber test specimen

The Izod unit calculations were as shown below:

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1.  $\text{Joule/Meter} = \frac{\text{Scale Reading (Joule)Instrument}}{\text{Sample Thickness in Meters}}$
2.  $\text{Kg.Joule/Meter} = \frac{\text{Scale Reading (Joule)Instrument}}{\text{Area of Sample (WxT)(Cross Section)}} \times 1000$

Where,

W= sample width in mm

T= sample thickness in mm

3.  $\text{Kg.cm/cm} = \frac{\text{Scale Reading (Joule)Instrument}}{\text{Thickness of sample in cm}} \times 10.1972$

The values were noted for each specimen after conducting experiment. The results obtained were shown as in below table IV.

TABLE IV  
IMPACT STRENGTH OF AEGLE MARMELOS COMPOSITE FIBERS

Weight of sample fiber (grams)	J	J/m	Kg.cm/cm
5	1	333.33	33.9906
10	0.25	83.33	8.497
15	0.9	300	30.5916
20	1.82	606.666	61.8630

## VIII. RESULTS AND DISCUSSION

The weights of composites before and after chemical treatment were noted for comparing. The following table V shows the comparison of weight below and after chemical treatment.

TABLE V  
COMPARISION OF WEIGHTS BEFORE AND AFTER CHEMICAL TREATMENT

Sample number	Weight before chemical treatment (grams)	Weight after chemical treatment (grams)
1	0.15	0.17
2	0.18	0.18
3	0.17	0.21
4	0.15	0.21
5	0.22	0.24
6	0.22	0.23
7	0.22	0.29
8	0.12	0.14
9	0.21	0.26
10	0.16	0.22



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The impact strength of Aegle Marmelos composite conducted using Izod impact strength were compared with the impact strengths of Nareepa and Jaana composite fibers. The following table VI shows the comparison of impact strength of Aegle Marmelos fiber composite with Nareepa and Jaana fiber composite.

TABLE VI  
COMPARISON OF IMPACT STRENGTH OF AEGLE MARMELOS WITH NAREEPA AND JAANA

Weight of sample (grams)	Nareepa (Kg.cm/cm)	Jaana (Kg.cm/cm)	Aegle Marmelos (Kg.cm/cm)
5	1.57	0.90	33.9906
10	1.94	3.09	8.497
15	0.57	1.63	30.5916
20	1.34	2.88	61.8630

## IX. CONCLUSION

From the results obtained from table V, it was observed that the treatment of composite fibers with chemicals exhibits variation in the weights of composites. As the weights increase after chemical treatment, density also increases which indicates better strength for the fibers. Thus proper chemicals must be selected while using composites in application according to the need. Proper precautions must be taken while preparing composites in mould so that errors will become minimum which leads to better results. The results of impact strength shown in table VI reveals that the impact strength of Aegle Marmelos fiber was better than that of Nareepa and Jaana fibers. Further experiments are needed for better understanding of Aegle Marmelos fiber composites.

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