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Mechanical And Machining Characteristics Of Calotropis Gigentea Fruit Fiber Reinforced Plastics

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Abstract

The interest in natural fiber reinforced polymer composite materials is rapidly growing both in terms of industrial applications and fundamental research. Natural fibers have recently become attractive to researchers, engineers and scientists as an alternative reinforcement for fiber reinforced polymer (FRP) composites. Due to their low cost, fairly good mechanical properties, high specific strength, non-abrasive, eco-friendly and bio-degradability characteristics, they are exploited as a replacement for the conventional fiber, such as glass, aramid and carbon. Several chemical modifications are employed to improve the interfacial matrix-fiber bonding resulting in the enhancement of mechanical properties of the composites. The present study of these paper to determine the mechanical and machining characteristics of the Calotropis Gigentea Fruit Fiber (i.e. Natural Fiber) composites.

Key words: Calotropis gigentea; Asclepiadaceae; Arka; Mudar; Fruit Fiber; Sintering; Fiber reinforced polymer (FRP); Ortho-phthalic acid

1. Introduction

1.1. Calotropis gigentea

Calotropis gigantea is a medium sized shrub or small tree that grows up to 4m high with a generally waxy appearance and copious milky sap. The stem is ash coloured, smooth, branching sometime almost from the base. [1] The leaves are grey-green, opposite, alternating, waxy, thick and rounded-ovate. They measure 5–15cm x 4–10cm with a short pointed tip and a heart-shaped base partly clasping the stem; a stiff brush of hairs occur at the base of the midvein. [2] The flowers are white with deep purple blotch at the base of each lobe and deep purple scales between the petals and the stamens; more or less tubular, 5-lobed, 2–3cm across, devoid of milky sap. [3] They are grouped in umbels in which the outer flowers open first while the inner do not develop fully. The fruit is a grey-green bladdery pod, 8–12 cm long, rounded at the base but shortly pointed at the tip and containing numerous seeds. The seeds are brown, flattened, with a tuft of long white hair at one end.

[4] Calotropis gigantea Linn (Asclepiadaceae) commonly known as “Arka” in Sanskrit and “Mudar” in English has been claimed in traditional literature to be valuable against a wide variety of diseases. [5] The shrub is distributed throughout India in dry waste

indian medicinal plants describe the use of this plant in the treatment of number of ailments including anorexia, asthma, cold and cough. Roasted leaves application is useful in painful joints or swellings [6].

I: Shows the Calotropis Gigantea plant

[7] The whole plant, root bark, roots, leaves and flowers are totreat many diseases and abnormalities in humans. Further, Oudhia and Tripathi [8] and Oudhia et al.[9–11] reported that extracts of different plant parts, viz. root, stem, leaf and stem + leaf of Calotropis affect germination and seedling vigour of many agricultural crops. [12] Its latex content and wild availability draw attention to its use in biomethanation. In a country like India where a huge population of livestock is present, biogas may be the prominent household energy source.

1.2. Properties of Calotropis Gigantea – Fruit

Flowers are replaced by a kidney-shaped fruit, 2.7 to 4 inches long. It is green and becomes brown when mature. [13] The fruit contains many seeds embedded in a rough fiber. The fruit is a follicle and when dry, seed dispersal is by wind. Fruits are fleshy follicles, green; seeds attached with abundant white coma. [14] The fruit is a grey-green bladdery pod, 8–12 cm long, rounded at the base but shortly pointed at the tip and containing numerous seeds. [15] The seeds are brown, flattened, with a tuft of long white hair at one end.

The fruit of the plant is green with an ovoid shape. [16] The flesh of the fruit contains a toxic milky sap that is extremely bitter and turns into a gluey coating resistant to soap [17]. Fruit is large producing a milky exudate when cut. Seeds winged, very numerous, each about 8-10 x 5 mm, attached by broad shiny, white funicles. Testa clothed in short, erect, and white hairs. Cotyledons ovate, shaped like a tombstone, much wider than the radical [18]. The fruit of Calotropis gigantea is oval and curved at the ends of the pods. The fruit is thick and when opened it is the source of thick fibers that have been made into rope and used in a multitude of ways.

1.3. Uses of a Calotropis gigantea (Fruit Fiber) and Plant:

The plant yields a durable fiber commercially known as bowstrings. The stem is useful for making ropes, carpets, fishing nets and sewing thread. [19] Fiber from the inner bark was once used in the manufacture of cloth for the nobility. Floss, obtained from the fruit, is used for stuffing purposes. The stem of the milkweed plant has also been used to extract oil and natural rubber [20, 21]. The potential of using milkweed plants as a source of pulp for paper was also studied [22]. Currently, milkweed plants are being commercially processed for floss used in comforters and other parts of the plants are also being sold. However, there are no reports available on the use of the milkweed stems as sources for high quality natural cellulose fibers.

1: Shows the Calotropis Gigantea – Fruit Fiber

2. Experimental Procedure

2.1. Fabrication of composite specimens

The standard test method for Tensile, Bending, Impact properties of fiber-resin composites, ASTM-

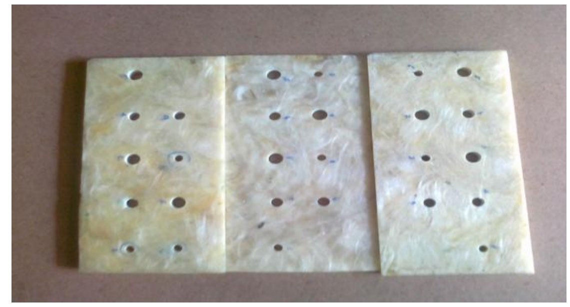
D790M-86 is used to prepare specimens as per the dimensions. The test specimen has a constant cross section with tabs bonded at the ends.

The mould is prepared on smooth ceramic tile with rubber shoe sole to the required dimension. Initially the ceramic tile is cleaned with shellac (NC thinner) a spirituous product to ensure clean surface on the tile. Then mould is prepared keeping the rubber sole on the tile. The gap between the rubber and the tile is filled with mansion hygienic wax. A thin coating of PVA (polyvinyl alcohol) is applied on the contact surface of specimen, using a brush. The resulting mould is cured for 24 hours. Hand layup method is adopted to fill the prepared mould with general-purpose polyester resin. ECMALON 4411 is an unsaturated polyester resin of ortho-phthalic acid grade with clear colourless or pale yellow colour. Cobalt accelerator and MEKP catalyst are added for curing the resin at room conditions.

Six such identical specimens are prepared for each fiber content in the specimen. Six different fiber contents 0.05, 0.10, 0.15, 0.20, 0.25, 0.30 grams are incorporated in the specimen. Two plain polyester specimens are also prepared in order to compare the results of natural fiber reinforced composites. The percentage volume of fiber present in the specimen is determined for each set.

Similarly for testing the machining characteristics of composite specimens we have prepared plates of different dimensions with different thickness and fiber contents weights with this thickness and dimensions are 0.5, 2.5, 3.5, 4.5, 6.5 gms. Two plain polyester specimens plates are also prepared in order to compare the results of natural fiber reinforced composites. The percentage volume of fiber present in the specimen is determined for each set.

ð Shows the Fabricated & Tested of Composite Specimens



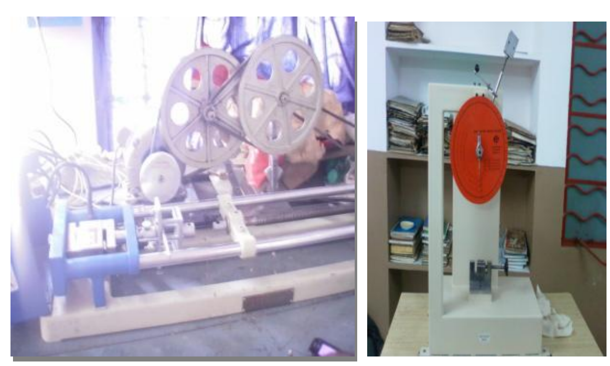
ð Shows the Fabricated & Machining of Composite Specimens

2.2. Testing (Tensile, Flexural & Impact) & Machining of Specimens

A 2 ton capacity - Electronic tensometer, METM 2000 ER-I model , supplied by M/S Mikrotech, Pune, is used to find the tensile strength of composites. Its capacity can be changed by load cells of 20Kg, 200Kg & 2000 Kg. A load cell of 2000 Kg. is used for testing composites. Self-aligned quick grip chuck is used to hold composite specimens. A digital micrometer is used to measure the thickness and width of composites.

This Instrument is used for testing the composite specimens for both i.e. For Tensile Strength & Flexural (Bending) Strength

While for testing the impact specimen composites we use analog Izod/ charpy impact tester supplied by M/S International Equipments, Mumbai (photo), was used to test the impact properties of fiber Reinforced composite specimen. The Equipment with a minimum resolution on each scale of 0.02 J, 0.05 J, 0.1 J and 0.2 J respectively .Four scales and corresponding hammers (R1,R2,R3,R4) are provided for all the above working ranges.



Shows the Equipment for Testing the Composite Specimens (Mechanical Characteristics)

For machining characteristics we are using the vertical CNC machine and we are using the following levels that are mentioned in the below Table.1, & Table.2 that are used for making the holes at different speeds, feeds, diameters. So that we can observe at what conditions it will withstand the capacity of machining conditions which means that at what speeds, feeds, and diameters it will withstand the capacity.

Drilling with different diameters, speeds and feeds for 200×100×3 mm, 200×100×5 mm, 200×100×7 mm up to 9 holes with different levels

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Holes	Speed	Feed	Diameter
1	1	1	1
2	1	2	2
3	1	3	3
4	2	1	2
5	2	2	3
6	2	3	1
7	3	1	3
8	3	2	1
9	3	3	2

Levels	1	2	3
Speeds	1000	1500	2000
Feeds	100	200	300
Diameters	6	8	10

Drilling with different diameters, speeds and feeds for 200×100×3 mm, 200×100×5 mm, 200×100×7 mm for 10th hole with different levels.

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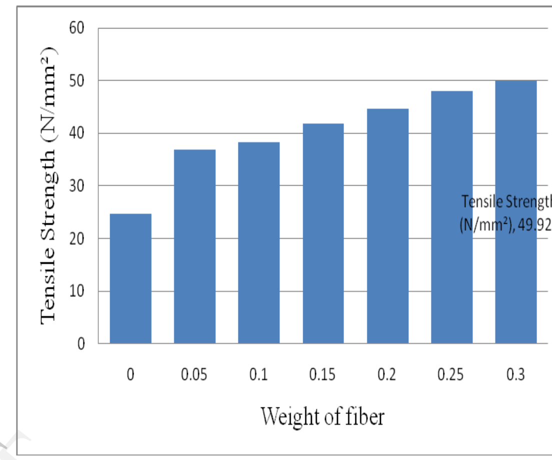
Hole	Speed	Feed	Diameter
10	1	1	1
10	2	2	2

Levels	1	2
Speeds	1250	1750
Feeds	150	250
Diameters	8.5	9

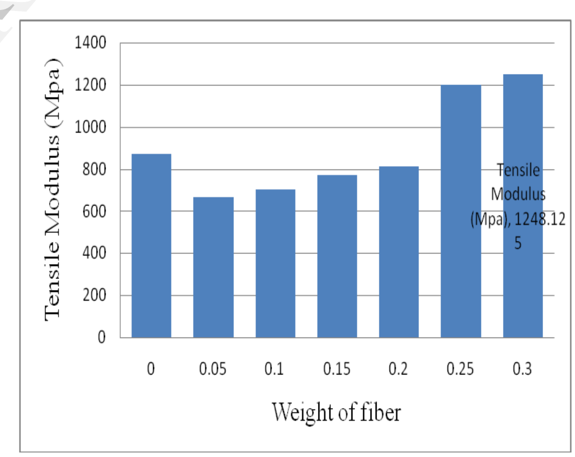
3. Results

In this work, we conducted testing the mechanical properties by using the equipment of Electronic tensometer and impact (izod) machine that has been proved to be an effective method to study the behaviour of materials under various conditions and phase composition of fibre composites and its role in determining the mechanical properties. The following results are.

3.1. Tensile strength & Tensile Modulus- It has been observed that composites with particle reinforcement showed more Tensile strength & Modulus when adding the each composition of fiber. It is clear from Figure 6 & Figure 7

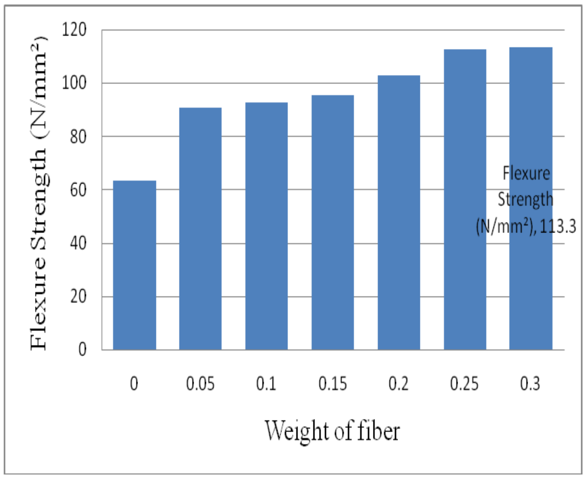


Shows the Tensile Strength of Fruit Fiber

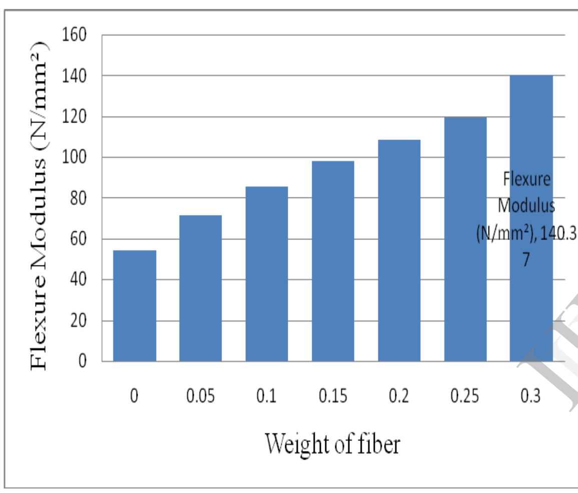


Shows the Tensile Modulus of Fruit Fiber

3.2. Flexural strength & Flexural Modulus- It has been observed that composites with particle reinforcement showed more Flexural strength & Modulus when adding the each composition of fiber. It is clear from Figure 8 & Figure 9

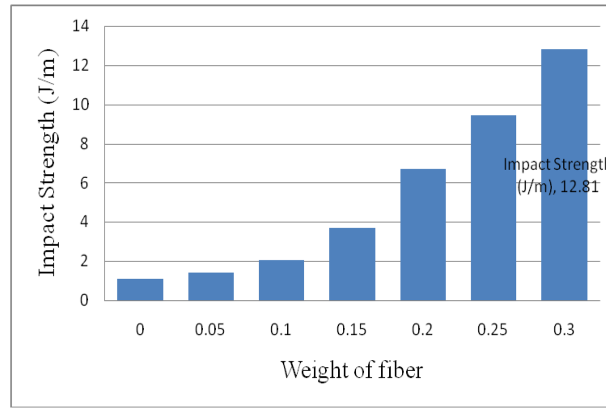


Shows the Flexural Strength of Fruit Fiber



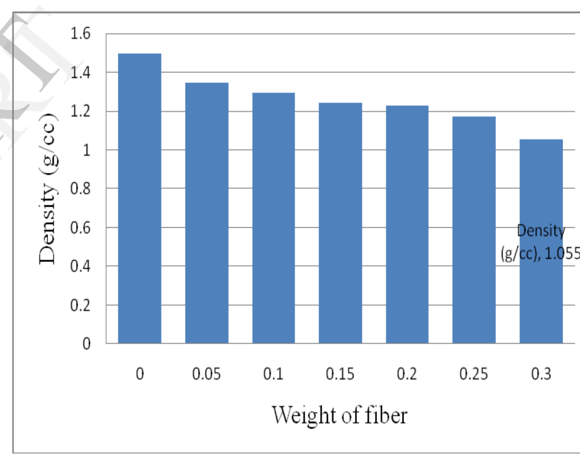
Shows the Flexural Modulus of Fruit Fiber

3.3. Impact Strength- It has been observed that composites with particle reinforcement showed more Impact strength when adding the each composition of fiber. It is clear from Figure 10



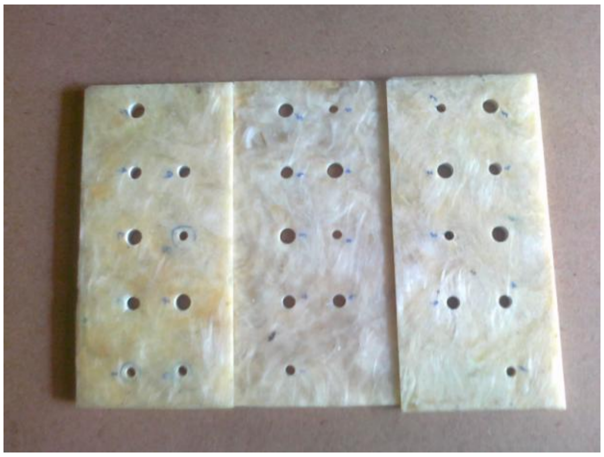
II Shows the Impact Strength of Fruit Fiber

3.4. Density of Composite- It has been observed that composites with particle reinforcement showed less density when adding the each composition of fiber which means that it has more strength. It is clear from Figure 11



II Shows the Density of composite of Fruit Fiber

3.5. Machining of Composite- For machining of composite we have taken the drilling process by using CNC machine centre we have taken the following parameters and mentioned in the above table and we have been observed that that we are adding the more amount of fiber in each composition of the plate the following parameters has minimising the machining conditions. It is clear from figure 12



I1 Shows the Machining of Composite specimen Plate

4. Conclusions

The conclusions has been given by conducting the above tests and obtained by the following graphs.

The tensile strength of 0.30 Gms weight percentage of Calotropis Gigentea fruit fiber reinforced composites is 49.925 N/mm² higher than that of 0% weight percentage reinforced composites.

The tensile modulus of 0.30 Gms weight percentage weight percentage of Calotropis Gigentea fruit fiber reinforced composites is 1248.125 Mpa higher than that of 0% weight percentage reinforced composites

The Flexural strength of 0.30 Gms weight percentage weight percentage of Calotropis Gigentea fruit fiber reinforced composites is 113.3 N/mm² higher than that of 0% weight percentage reinforced composites.

The Flexural modulus of 0.30 Gms weight percentage weight percentage of Calotropis Gigentea fruit fiber reinforced composites is 140.37 N/mm² higher than that of 0% weight percentage reinforced composites.

The Impact energy of 0.30 Gms weight percentage weight percentage of Calotropis Gigentea fruit fiber reinforced composites is 12.81 J/m higher than that of 0% weight percentage reinforced composites.

For machining we have observed that when we increase the fiber with respect to increment in the plates and by increasing the levels it was higher than the 0% of the plates and also that the cracks and delaminations occurred in the plate of 6.5 weight is less when compared to 0% weight of fiber plate

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