

Impact and Chemical Tests on Natural Fiber Reinforced Epoxy Composite Material

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ABSTRACT: Natural fibers are the other alternative in which the research is being carried out to overcome the problem of using metals due to its distinct characteristics like low cost, less weight, biodegradability etc. In this paper an attempt is made to prepare two different composite materials using **Rose Madder (Rubia Cordifolia)** and **Burmese Silk Orchid (Bauhinia Racemosa)** as reinforcement and **Epoxy** as the matrix material respectively. Composites were prepared by increasing the weight of fibers like 5,10,15,20 grams for reinforcement respectively by Hand Layup technique. Impact testing of the material was done by cutting the material into ASTM standards on an IZOD Impact Tester. Chemical tests were conducted for the respective composite materials by cutting some specimen from the material and immersing it in the chemicals like Sodium Hydroxide, Benzene, Toluene, Ammonium Hydroxide etc. It was found that as the weight of fiber increases there is improvement in the impact properties of the composite material and also its chemical properties towards various chemicals

KEYWORDS: composite, Natural Fibers, epoxy, hand layup, impact, chemical

I. INTRODUCTION

Research on natural fiber composites has existed since the early 1900's but has not received much attention until late in the 1980's. Composites, primarily glass but including natural reinforced composites are found in countless consumer products including: boats, skis, agricultural machinery and cars. Composite materials are made up of two or more materials on a macroscopic scale possessing hybrid properties of all the materials in the composite. Polymer matrix composites are plastics (resins) within which there are embedded fibres. The plastic is known as the matrix, and the fibres orientated within it are known as the reinforcement. The reinforcement tends to be stiffer and stronger than the matrix providing stiffness and strength. Reinforcement is laid in a particular direction, within the matrix; so that the resulting material will have different properties in different directions i.e. composites have anisotropic properties. This characteristic is exploited to optimise the design and provide high mechanical performance where it is needed. There are two types of constituent materials: matrix and reinforcement. At least one portion (fraction) of each type is required. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions and its main function is to transfer the load between reinforcement components for a better composite material. The reinforcements impart special physical (mechanical and electrical) properties to enhance the matrix properties. The points to be noted in selecting the reinforcements include compatibility with matrix material, thermal stability, density, melting temperature etc. Fig.1 shows the various types of reinforcements used in composites.

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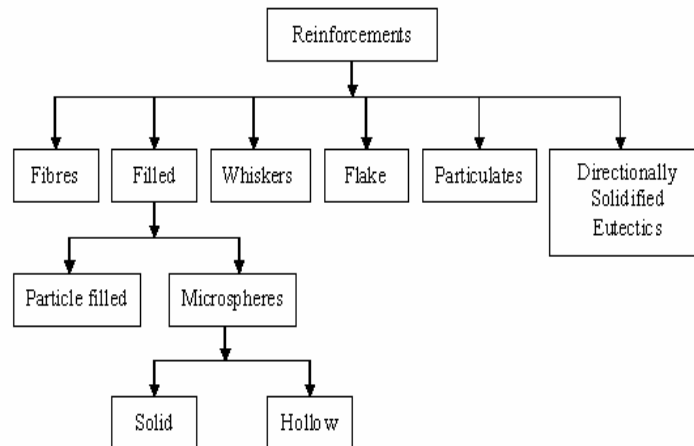


Fig.1 types of reinforcements

Fibers are of two types, namely natural fibers and synthetic fibers. Natural fibers such as bamboo, sisal, jute etc are used as reinforcement and either thermoset or a thermoplastic are used as matrix. Synthetic fibers are polysters, aramide, nylon etc. The fibers may be continuous (long) or discontinuous (short).

The matrix must have a mechanical strength commensurate with that of the reinforcement i.e. both should be compatible. Thus, if a high strength fibre is used as the reinforcement, there is no point using a low strength matrix, which will not transmit stresses efficiently to the reinforcement. The matrix must stand up to the service conditions, viz., temperature, humidity, exposure to ultra-violet environment, exposure to chemical atmosphere, abrasion by dust particles, etc. It should not be toxic and should have a high flash point.

II. MATERIAL

Rose Madder (*Rubia Cordifolia*) and Burmese Silk Orchid (*Bauhinia Racemosa*) fibers were peeled off from the barks collected from their respective trees which are present in Nallamalla forest at Bailrooty area in Andhra Pradesh. Fibers are cut to a length equal to the length of the mould. Epoxy mixed with hardener was used as matrix material. Epoxy and hardener were mixed at a ratio of 20:1 respectively. Glass mould with the dimensions 200mm x 200mm x 3mm (length x width x thickness) was used for the preparation of the composite. Other ingredients which were helpful in preparing the composite are releasing agent, OHP paper and a roller.

III. EXPERIMENTAL SETUP

The releasing agent used is hard wax which is applied over the mould such that the wax is equally spread and it is dried for about half an hour. Epoxy and hardener are thoroughly mixed in a separate beaker. The composite material is prepared by using Hand Layup Technique and the mould was covered with an OHP paper and weights were kept on it. While performing hand layup technique care should be taken to avoid formation of voids within the composite. After that mould was kept for about 24 hours to get hardened. After 24 hours the mould was kept in an oven for 20 minutes such that the releasing agent gets melted and it will be easy to remove the composite material from the glass mould. And then the composite material was kept in the oven for about one hour for curing purpose. After curing the material is kept under weights so that the material gets a uniform shape like the shape of the mould cavity.

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Vol. 4, Issue 9, September 2015

Chemical Testing

The material is cut into ten specimens with dimensions 10mm x 5mm x 3mm for chemical test as per ASTM D 543-87 specifications. The preweighted specimens were immersed in ten different chemicals for 24 hours in a test tube and then were removed, rinsed with distilled water and dried by pressing them on both sides with a filter paper at room temperature. The specimens were reweighted and the % weight gain/loss was recorded with the formula below.

$$W = \frac{w_2 - w_1}{w_1}$$

Where W - Gain/loss weight of final specimen.

w₁ - weight of specimen before immersing in chemical.

w₂ - weight of specimen after immersing in chemical.

Impact Testing

The material is cut into specimens with dimensions 120mm x 13mm x 3mm and a notch was made at the centre of the specimen at 45 degrees angle for impact testing as per ASTM D 256-88 specifications. The impact strength of the specimen is determined using IZOD impact tester.

The IZOD Impact tester consists of a pendulum of known mass and length that is dropped from a known height to impact a notched specimen of the material. For this test a notched specimen is fixed between supports. The machine has the following specifications. The image of machine is shown in Fig.2.

Display	:	Digital Indicating Unit.
Scale range	:	2, 4, 7.5, 15, 25 Joules.
Hammers	:	Two.
Power supply	:	230V AC, 50Hz, Single Phase.



Fig.2 IZOD Impact Tester

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(An ISO 3297: 2007 Certified Organization)

Vol. 4, Issue 9, September 2015

IV. RESULTS AND DISCUSSION

Chemical Test

Chemicals used for the tests are Nitric acid, Hydrochloric acid, Acetic acid, Sodium Hydroxide, Sodium Carbonate, Ammonium Hydroxide, Benzene, Toluene, Carbon Tetrachloride and Distilled water. The test is performed carefully so that our hands are not exposed directly to the chemicals. Table I and Table II show the chemical test values of the specimens of Rose Madder and Burmese Silk Orchid fiber reinforced epoxy matrix composites respectively. Weight of specimen before immersing in chemical (w_1) and weight of specimen after immersing for 24 hours (w_2) are noted and the gain/loss weight of the specimen (W) is calculated.

TABLE I
CHEMICAL TEST VALUES OF ROSE MADDER

Chemicals	W_1	W_2	$W = \frac{w_2 - w_1}{w_1}$
40% nitric acid	0.32	0.29	-0.09
10% Hydrochloric acid	0.31	0.32	+0.03
8% Acetic acid	0.29	0.32	+0.103
10% sodium hydroxide	0.24	0.30	+0.25
20% sodium carbonate	0.26	0.31	+0.19
10% Ammonium Hydroxide	0.31	0.39	+0.25
Benzene	0.27	0.36	+0.33
Toluene	0.23	0.22	-0.04
Carbon tetrachloride	0.27	0.32	+0.18
Distilled Water	0.20	0.22	+0.1

TABLE II
CHEMICAL TEST VALUES OF BURMESE SILK ORCHID

Chemicals	W_1	W_2	$W = \frac{w_2 - w_1}{w_1}$
40% nitric acid	0.21	0.24	+0.142
10% Hydrochloric acid	0.15	0.20	+0.33
8% Acetic acid	0.20	0.27	+0.35
10% sodium hydroxide	0.20	0.25	+0.25
20% sodium carbonate	0.17	0.21	+0.23
10% Ammonium Hydroxide	0.24	0.27	+0.12
Benzene	0.29	0.32	+0.10
Toluene	0.26	0.29	+0.11
Carbon tetrachloride	0.18	0.26	+0.44
Distilled Water	0.25	0.25	0

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Vol. 4, Issue 9, September 2015

Impact Test

The weight of fiber is taken as 5,10,15,20 grams respectively. First the pure epoxy is tested and then the fiber reinforced composites are tested with different fiber weights.

The IZOD unit calculations were as shown below:

1.
$$\text{Joule/Meter} = \frac{\text{Scale Reading (Joule) Instrument}}{\text{Sample Thickness in Meters}}$$
2.
$$\text{Kg.cm/cm} = \frac{\text{Scale Reading (Joule) Instrument}}{\text{Thickness of sample in cm}} \times 10.1972$$

Fig.3 and Fig.4 shows the Impact specimens of Burmese Silk Orchid fiber and Rose Madder fiber composites respectively



Fig.3 Burmese Silk Orchid fiber composite impact specimen



Fig.4 Rose Madder composite impact specimen

Table III and Table IV show the Impact testing values of Rose Madder and Burmese Silk Orchid fibers reinforced epoxy matrix composites respectively.

TABLE III
IMPACT TESTING VALUES OF ROSE MADDER

Weights of Fibers in Composite	Joule	Joule/m (SI)	Kg.cm/cm (ASTM)
0 grams (pure epoxy)	0.11	36.6	3.73
5 grams	0.97	323.33	32.97
10 grams	1.21	403.33	41.12
15 grams	1.43	476.66	48.6
20 grams	1.76	588	59.82

International Journal of Innovative Research in Science, Engineering and Technology

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Vol. 4, Issue 9, September 2015

TABLE IV
IMPACT TESTING VALUES OF BURMESE SILK ORCHID

Weights of Fibers in Composite	Joule	Joule/m (SI)	Kg.cm/cm (ASTM)
0 grams (pure epoxy)	0.11	36.6	3.73
5 grams	0.80	266.66	27.19
10 grams	1.12	373.33	38.06
15 grams	1.37	456.66	46.56
20 grams	1.63	543.33	55.40

V. CONCLUSION

From the results of both the tests we can conclude that both Rose Madder and Burmese Silk Orchid are almost have less weight changes towards different chemicals so we can use these both fiber reinforced composites in areas which are prone to acidic activity and can be used in various other applications like inner coverings in water tanks etc. The impact strengths of both the fibers show that as the fiber weight increases within a composite those composites have better impact strengths. Rose Madder fiber composite has higher impact strength than Burmese Silk Orchid fiber composite. From the broken pieces while performing impact testing show that breakage is caused due to small voids between the fibers and matrix material due to which there will be lesser adhesion between the fiber surface and the matrix material. So care should be taken to avoid formation of cavities within the composite while performing hand layup technique

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