To Study Mechanical Behavior of Composites based on Re-Reeling Mulberry Silk Waste with Unsaturated Polyester Resin.

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Abstract

Polymeric materials reinforced with fiber such as glass, carbon fiber provide advantages of high strength to low weight ratio and their uses are very well justified in various applications. Despite these advantages, the wide spread use of synthetic fiber-reinforced polymer composite is declining because of their higher cost and adverse environmental impact. On the other hand the uses of natural fiber to develop environment friendly green materials are attracting researchers worldwide due to their advantages like low cost, low density, non-toxicity, comparable strength, and minimum waste disposal problems. The mulberry silk is one of the strongest natural protein fiber widely used for clothing purposes with known feature as costliest, luxurious, lustrous textile material & called as queen of textile fibers, utilization of Mulberry silk waste can replace hazardous effect of glass composites as well step towards the preparation of green material with special characteristic of silk like low density and high strength has encouraged to study this topic. This research is an attempt to use various loading or reinforcement percentage of silk waste with UPR to find the impact of reinforced material on mechanical behavior of composites like tensile, flexural and impact strength. The material has a biocompatibility can be used in Bio-engineering or value added product in various applications. The various reinforcement percentage of silk waste used are3, 6, 9, 12, 15%, the tensile strength at loading of 9 wt. % of silk waste fiber gives results of 356.69 kg/cm2 while flexural strength found to be2445.24 kg/cm2Whereas the izod impact strength is found to be 0.71Kg/cm

Key words: composites, polymer, silk, UPR (unsaturated polyester resin).

Introduction

Natural fibers are an attractive research area because they are eco-friendly, abundant and renewable, lightweight, low density, high toughness, high specific properties, biodegradability and non-abrasive to processing characteristics, and lack of residues upon incineration. Silk fiber is a valuable resource with high Tenacity, low densitycan be used in a great many value added products. Mulberry silk is popularly used in handloom for making sarees& fancy garments. So utilization of continuous filament for composites may not be advisable, using mulberry Re-reeling silk waste for composite has advantageous for Techno economics as a value added product like composites. Silk is renewable, versatile, nonabrasive, porous, hydroscopic, elastic, biodegradable, combustible, computable and reactive. The fiber has a high aspect ratio, high strength to weight ratio, and has good insulation properties. This paper deals with Experimental research for preparation of composites with combination of Re-Reeling silk waste and unsaturated polyester resin with varying % of silk waste as reinforced material. Composites can be cost-effective material especially for building & construction industry (panels, false ceilings, partition boards, Fancy Tiles etc.), packing, automobile, railway coach interiors and storage devices and may be for Bio Engineering, the price of mulberry raw silk filament is very high as compared to re-reeling waste almost one fourth of it, in order to find an application to this valuable waste, the present work an attempt to develop polymer matrix composite. Primary efforts are made to study the mechanical behavior of these composites by various testing like Tensile, Flexural & Impact strength of product. Though extensive work has carried out on cellulosic natural fiber composites and little attention is given on preparation of composites by protein natural fiber. This experimentation results will form directions for utilization of strongest natural fiber waste for value addition, the primary results are the indicatives for replacement or to reduce the % share of hazardous fibers in composites. The major threat for this fiber is of poor resistance to moisture absorption, efforts can be made to overcome.

Composites

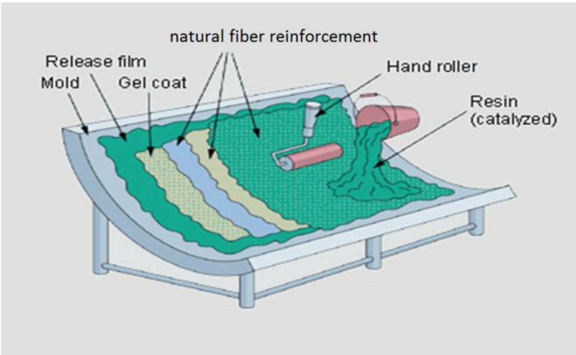
A composite is a combined material created by the synthetic assembly of two or more components together which are insoluble and chemically distinct in each other. The basic constituents of such a material are resin (which is in continues phase) and the fibers (which are in discontinues phase) and sometimes other fillers are combined in other that the composite material exploits the best of the individual qualities. [1] Matrix can be defined as continuous phase which holds or binds the other phase viz., reinforcement together. It is in ductile nature. Matrix separates the fibers and due to its relative softness, flexibility and plasticity, prevents the propagations of brittle cracks from fiber to fiber [2].Typical resins include polyester, epoxy, polyurethane, polyamide, ABS, polypropylene, USP. The functions of matrix are:

1. Holds or binds the reinforcement together.
2. It prevents the reinforcement from external or environmental attacks.
3. It transfers the external load to the reinforcement.

Reinforcement is a discontinuous phase material which is responsible for mechanical properties of the composite. They are brittle in nature and susceptible to the environmental attacks. The main purpose to add reinforcement is to provide additional strength and to improve certain physical properties of the resin. Typical examples of reinforcement are jute, bamboo, glass fibers, carbon fibers, etc. the reinforcement improves mechanical properties of the composite material and distributes the transfer load provided by the matrix [1]. By comparing silk fiber with conventional glass fiber, it possesses lower density than the glass fiber. Matrix: For manufacturing composites based on re-reeling mulberry silk waste fiber, unsaturated polyester resin (UPR) and hardener Methyl Ethyl Ketone Peroxide (MEKP) with cobalt octet as an accelerator were used with reinforced material glass sheet pairs as mould, wax as a mould releasing agent with mould dimension of 220x220x13mm. The sheet of composite is made by 375ml resins with 2% hardener & 4% cobalt accelerator, Silk fiber possesses standard mulberry silk properties like linear density is 1.17 dtex.

Method of preparation for composite

Chemical Treatment of Fibers: Before using the re-reeling mulberry silk waste fiber directly as a reinforcing agent they are first treated by starch to modify the surface of the fibers this leads to better dispersion of the fibers into the matrices and can have better binding of fibers and their loading ratio. Starch increases wet ability of silk fiber. In Hand Lay-up Technique resins with calculated amount of MEKP (hardening agent) and Cobalt octet (accelerator) are impregnated by hand into silk fibers which are in the form randomly layered fiber sheet in predetermined sample size, the surface properties of the fiber is improved by starch. This is usually accomplished by roller or brushes, with an increasing use of nip-roller type impregnator for forcing resin into the fibers by means of rotating rollers and a bath of resin. The required pressure is applied and excess solid resin trimmed and left to cure under standard atmospheric conditions.



Following procedure was adopted for preparation of composites:

1. Right quantity of resin and the treated silk fibers in predetermine ratio was taken.
2. After taking the material in desire quantity first the mold is prepared and two operation need to be done that are cleaning of mold and applying the mold release agent.
3. Calculated amount of hardener and accelerator were added into the system. Care must be taken that the hardener and accelerator should not be added at the same time so that excess of exothermocity of the reaction can be controlled.
4. After preparing the resin with curing system in the pot the half quantity is poured in to the mold in such way that it reach to the each corner of mold and sprier uniformity. The thickness and final properties are largely depends on the way of pouring. To achieve the uniformity the after pouring the material mold is move up and down from any two side. In this method the manual skill is most important.
5. As the silk fibers having very low density an available in random form it create most of problems. It should be placed in such way that it gives the uniform thickness.
6. Remaining resin then poured on the fibers it is make sure that all fibers get wet and not come on the surface. The outer surface finish depends on this layer rollers can be used for better surface finish.

7. Depending upon the resin, curing system and the curing time. The adequate pressure is applied and mold is kept on the flat surface until it gets cured completely.
8. After it gets cured the marking is done on the sheet for the cutting in required dimensional templates as per the ASTM standard, minimum stress should be developed while cutting the samples.

Fig- Mulberry re-reeling silk waste

Fig- Composite sheets with different weight fraction of mulberry re-reeling silk waste.

Sample Testing

The prepared composite samples were tested for tensile strength, elongation at break, flexural strength and izod impact strength. Universal testing machine was used for measuring tensile and flexural strength. The multidirectional composite specimens were made as per the ASTM D638M to measure the tensile properties. The length, width and thickness of the specimen were 16, 1.4 and 0.63cm, respectively. For flexural strength testing specimen having dimension of span length 10cm, width 1.3cm and thickness varies according to different weight fraction of fiber. Izod impact tester (ASTM D256) is used to test impact strength of composites. It test the resistance offered by specimen when certain amount of force is applied on it. Thickness is also important factor to calculate the impact strength of specimen, all these composite sheets having random arrangement of fibers. The actual composition of fiber, hardener & accelerator weight used in various sheets of composite.

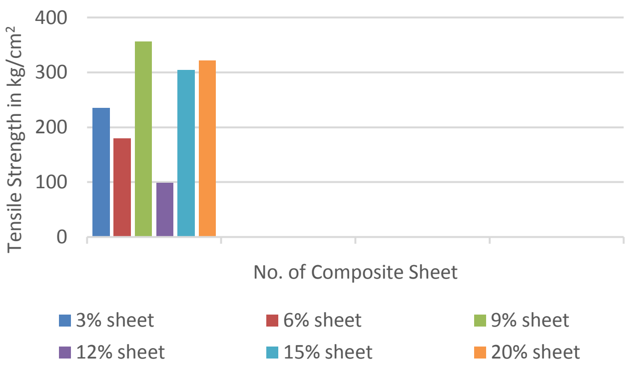
	Fiber wt. (random orientati-on)	**Actual Resin Used (in ml)**	**Hardener (wt. of Actual resin used)**	**Accelerator (wt. of Actual resin used)**
1st sheet (3%)	11.25 gm	375 ml	2%	4%
2nd sheet (6%)	22.5gm	375 ml	2%	4%
3rd sheet (9%)	33.75 gm	375 ml	2%	4%
4th sheet (12%)	45 gm	375 ml	2%	4%
5th sheet (15%)	56.25gm	375 ml	2%	4%
6th sheet (20%)	75 gm	375 ml	2%	4%

Experimental Testing Results

The tensile properties of reeling mulberry silk waste fiber composites along with different weight fraction.

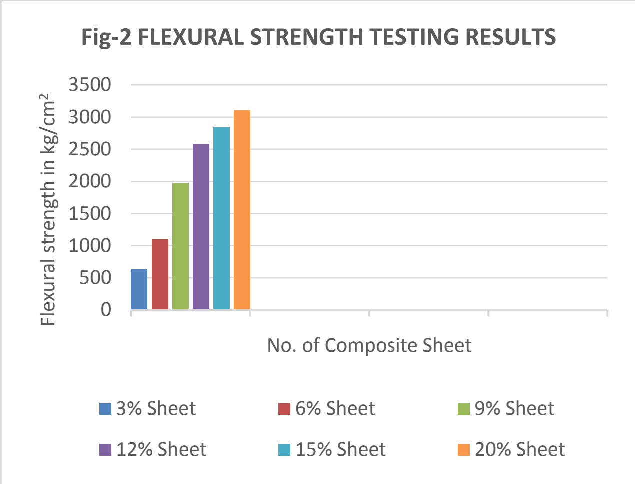
Sample	Thick-ness (cm)	Width (cm)	Breaking load (kg)	Tensile Strength (kg/cm2)	Tensile Strength (Mpa)	Elonga-tion %
3%	0.63	1.4	207.5	235.26	23.07	7.6%
6%	0.63	1.4	158.7	179.93	17.64	6.90%
9%	0.63	1.4	314.6	356.69	34.98	9.2%
12%	0.63	1.4	87.3	98.98	9.7	6.2%
15%	0.63	1.4	268.4	304.3	29.84	7.6%
20%	0.63	1.4	284.4	322.45	31.62	8.60%

Fig-1 TENSILE STRENGTH TESTING RESULTS



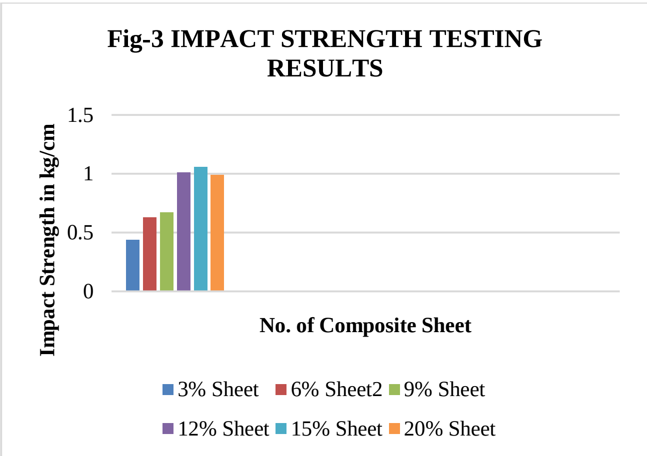
The flexural properties of reeling mulberry silk waste fiber composites along with different weight fraction.

Sample	Thickness (cm)	Width (cm)	Breaking load (kg)	Flexural strength (kg/cm2)	Flexural strength (Mpa)
3%	0.63	1.3	22	639.57	62.72
6%	0.63	1.3	38	1104.71	108.33
9%	0.63	1.3	68	1976.86	193.86
12%	0.63	1.3	89	2587.36	253.73
15%	0.63	1.3	98	2849	279.39
20%	0.63	1.3	107	3110.64	304.05



The impact strength of reeling mulberry silk waste fiber composite along with different weight fraction

Sample	Thickness (cm)	Width (cm)	Resistance offered (kg)	Impact strength expressed as energy lost per unit of thickness (kg/cm)
3%	0.63	1.3	0.28	0.44
6%	0.63	1.3	0.4	0.63
9%	0.63	1.3	0.42	0.67
12%	0.63	1.3	0.64	1.01
15%	0.63	1.3	0.67	1.06
20%	0.63	1.3	0.625	0.99



Inference

Tensile: It is observed that the tensile strength of 9 wt. % of sample having highest strength than the other samples. However the tensile strength decreased with further increase in the wt. % of mulberry re-reeling silk waste fiber reinforcement.

Flexural properties: The flexural strength linearly increased. It is observed that as the fiber weight fraction increases the flexural strength also increases. The sample of 20 wt. % shows the highest flexural strength than any other samples.

Impact properties: The impact strength of 15 wt. % of Mulberry re-reeling silk waste fiber reinforced composite exhibited the highest impact strength. It is observed that as the fiber weight fraction increases the impact strength also increases but up to a certain limit then it falls down.

Conclusions

The effect of mulberry re-reeling silk fiber wastes as reinforcement material with unsaturated polyester resin composites was studied on primary basis. Incorporation of the waste in the composites enhanced considerably the mechanical properties such as tensile, flexural and impact strength. These results are evidence that the mulberry re-reeling silk fiber wastes are an efficient alternative and comparable with other fibers reinforced composites for their cycling and further research can add more probabilities for replacement of these fibers with other popular fiber reinforcement.

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