Experimental and Investigation of Leaf Spring by using Bamboo and Coconut Fiber with Epoxy Composite

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***Abstract*: In present year's natural fiber composite material locale a major role in industries like aerospace and automobile. The natural fiber is amplified by hook up with plastics. The sample availability of natural fibers such as coir, Bamboo And Coconut Fiber ,ramie, sisal, jute, banana, bagasse etc. Common matrix materials include epoxy, phenol, polyester, polyurethane vinyl ester etc.The composites formed by fibres gained attention due to their low cost, light weight, renewability, low density, high specific strength, none abrasively, non toxicity and biodegradability etc. In this paper discussed the Composite material Plate by using Bamboo and Coconut Fiber with Epoxy composite and to evaluate the Mechanical properties of leaf spring (Tensile strength, Hardness, Toughness Examination).**

INTRODUCTION:

In recent years, polymeric based composites materials are being used in many application such as automotive, sporting goods, marine, electrical, industrial, construction, household appliances, and etc.Polymeric composites have high strength and stiffness, light weight, and high corrosion resistance.

Natural fibres are available in abundance in nature and can be used to reinforce polymers to obtain light and strong materials. The natural fiber present important advantages such as low density, appropriate stiffness, mechanical properties with high disposability and renewability. In this project are used the natural fibre of banana. Moreover, these banana fibres are recycle and biodegradable

A composite material can be defined as a combination of two or more materials that results in better properties than those of the individual components used alone. In contrast to metallic alloys, each material retains its separate chemical, physical, and mechanical properties. The two constituents are reinforcement and a matrix. The main advantages of composite materials are their high strength and stiffness, combined with low density, when compared with bulk materials, allowing for a weight reduction in the finished part.

The reinforcing phase provides the strength and stiffness. In most cases, the reinforcement is harder, stronger, and stiffer than the matrix. The reinforcement is usually a fiber or a particulate. Particulate composites have dimensions that are approximately equal in all directions. They may be spherical, platelets, or any other regular or irregular geometry. Particulate composites tend to be much weaker and less stiff than continuous fiber composites, but they are usually much less expensive. Particulate reinforced composites usually contain less reinforcement (up to 40 to 50 volume percent) due to processing difficulties and brittleness. A fiber has a length that is much greater than its diameter. The length-to- diameter (l/d) ratio is known as the aspect ratio and can vary greatly.

Continuous fibers have long aspect ratios, while discontinuous fibers have short aspect ratios. Continuous-fiber composites normally have a preferred orientation, while discontinuous fibers generally have a random orientation. Examples of continuous reinforcements include unidirectional, woven cloth, and helical winding. While examples of discontinuous reinforcements are chopped fibers and random mat.

Continuous-fiber composites are often made into laminates by stacking single Sheets of continuous fibers in different orientations to obtain the desired strength and stiffness properties with fiber volumes as high as 60 to 70 percent. Fibers produce high-strength composites because of their small diameter; they contain far fewer defects (normally surface defects) compared to the material produced in bulk.

LEAF SPRING

Leaf springs are mainly used in suspension systems to absorb shock loads in automobiles like light motor vehicles, heavy duty trucks and in rail systems. It carries lateral loads, brake torque; driving torque in addition to shock absorbing the advantage of leaf spring over helical spring is that the ends of the spring may be guided along a definite path as it deflects to act as a structural member in addition to energy absorbing device. According to the studies made a material with maximum strength and minimum modulus of elasticity in the longitudinal direction is the most suitable material for a leaf spring.

To meet the need of natural resources conservation, automobile manufacturers are attempting to reduce the weight of vehicles in recent years. Weight reduction can be achieved primarily by the introduction of better material, design optimization and better manufacturing processes. The suspension leaf spring is one of the potential items for weight reduction in automobiles un sprung weight. This achieves the vehicle with more fuel efficiency and improved riding qualities. The introduction of composite materials was made it possible to reduce the weight of leaf spring without any reduction on load carrying capacity and stiffness for weight reduction in automobiles as it leads to the reduction of un sprung weight of automobile.

The elements whose weight is not transmitted to the suspension spring are called the un-sprung elements of the automobile.

Figure A 1 traditional leaf spring arrangement

This includes wheel assembly, axles, and part of the weight of suspension spring and shock absorbers. The leaf spring accounts for 10-20% of the un-sprung weight the The properties and performance of composi composite materials made it possible to reduce the weight of machine element without any reduction of the load carrying capacity. Because of composite material's high elastic strain energy storage capacity and high strength-to-weight ratio compared with those of steel. FRP springs also have excellent fatigue resistance and durability. But the weight reduction of the leaf spring is achieved not only by material replacement but also by design optimization. Weight reduction has been the main focus of automobile manufacturers in the present scenario. The replacement of steel with optimally designed composite leaf spring can provide 92% weight reduction. Moreover the composite leaf spring has lower Stresses compared to steel spring. All these will result in fuel saving which will make countries energy independent because fuel saved is fuel produced

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are far superior to those of the constituents

 Composites consist of one or more discontinuous phases (reinforcement) embedded in a continuous phase (matrix)

EXAMPLES: –

 Cemented carbides (WC with Co binder)

 Rubber mixed with carbon black

 Wood (a natural composite as distinguished from a synthesized composite)

Applications:

OBJECTIVES OF THE PRESENT RESEARCH WORK

Following are the objectives that have been outlined keeping in mind the Knowledge gap:

ew class of epoxy based hybrid composite reinforced with Short aloe Vera and coconut fiber fibers.

 To study the influence of stir casting method on mechanical behavior of coconut and aloe Vera fiber reinforced epoxy based hybrid composites.

n of mechanical properties such as tensile strength, flexural toughness and micro- hardness

INTRODUCTION OF COMPOSITES

 Composite is a combination of two or more chemically distinct and insoluble phases.

 Constituent materials or phases must have significantly different properties for it to combine them: thus metals and plastics are not considered as composites although they have a lot of fillers and impurities

Merits of composite materials composites Can be very strong and stiff, yet very light in weight, so ratios of strength-to-weight and stiffness-to-weight are several times greater than steel or aluminium

 High specific strength and

 High specific stiffness Long fatigue life

 High creep resistance Low coefficient of thermal expansion

 Low density

 Low thermal conductivity

 Better wear resistance Improved corrosion resistance

 Better temperature dependent behaviour.

APPLICATIONS

Space craft: Antenna structures, solar reflectors, Satellite structures, Radar, Rocket engines, etc.

Aircraft: Jet engines, Turbine blades, Turbine shafts, Compressor blades, Airfoil surfaces, Wing box structures, Fan blades, Flywheels, Engine bay doors, Rotor shafts in helicopters, Helicopter transmission structures, etc.

Miscellaneous: Bearing materials, Pressure vessels, Abrasive materials, Electrical machinery, Truss members, Cutting tools, Electrical brushes, etc.

C/C composites meet applications ranging from rockets to aerospace because of their ability to maintain and even increase their structural properties at extreme temperatures.

Advantages:

 Extremely high temperature resistance (1930°C – 2760°C).

 Strength actually increases at higher temperatures (up to 1930°C).

 High strength and stiffness.

 Good resistance to thermal shock.

Uses of composites

The biggest advantage of modern composite materials is that they are light as well as strong. By choosing an appropriate combination of matrix and reinforcement material, a new material can be made that exactly meets the requirements of a particular application.

Composites also provide design flexibility because many of them can be moulded into complex shapes. The downside is often the cost. Although the resulting product is more efficient, the raw materials are often expensive.

Automobile: Engines, bodies, Piston, cylinder, connecting rod, crankshafts, bearing materials, etc.

MATERIALS FOR LEAF SPRING

The material used for leaf springs is usually a plain carbon steel having 0.90 to 1.0% carbon. The leaves are heat treated after the forming process. The heat treatment of spring steel products has greater strength and therefore greater load capacity, greater range of deflection and better fatigue properties**.**

Carbon/Graphite fibers

Their advantages include high specific strength and modulus, low coefficient of thermal expansion and high fatigue strength. Graphite, when used alone has low impact resistance. Its drawbacks include high cost, low impact resistance and high electrical conductivity.

GLASS FIBERS

The main advantage of Glass fiber over others is its low cost. It has high strength, high chemical resistance and good insulating properties. The disadvantages are low elastic modulus poor adhesion to polymers, low fatigue strength and high density, which increase leaf spring weight and size. Also crack detection becomes difficult

PROBLEMS IDENTIFICATION

Problem Definition The suspension leaf spring is one of the potential items for weight reduction in automobile as it accounts for ten to twenty percent of the un-sprung weight. The introduction of composites helps in designing a better suspension system with better ride quality if it can be achieved without much increase in cost and decrease in quality and reliability. The relationship of the specific strain energy can be expressed as it is well known that springs, are designed to absorb and store energy and then release it slowly. Ability to store and absorb more amount of strain energy ensures the comfortable suspension system. It can be easily observed that material having lower modulus and density will have a greater specific strain energy capacity. The introduction of composite materials made it possible to reduce the weight of the leaf spring without reduction of load carrying capacity and stiffness due to more elastic strain energy storage capacity and High strength to weight ratio

SELECTION OF COMPOSITE MATERIAL

This chapter describes the details of processing of the composites and the experimental procedures followed for their mechanical characterization. The materials used in this work are

 Bamboo fiber

 Coconut fiber

 Epoxy

BAMBOO STICK FIBER

FIG A 2 BAMBOO FIBER

Bamboo has been one of the common materials in pre-industrial architecture in Asia and South American countries, employed as structural elements. The utilization of bamboo as construction component is motivated by its widespread availability in the tropical and subtropical climatic regions, its rapid growth and the combination o f elevated mechanical strength and low specific weight. However, at the present time, even the most modern construction where bamboo is used rely on a craft approach, with the know-how of construction techniques restricted to a small group of researchers, engineers and architects. Although bamboo has an immense potential, standardization and a definition of a correct construction practice still present some difficulties. Actually, there is an on-going research on bamboo with regards to special treatments leading to higher durability ,improved connectors and mathematical modelling for the structural analysis of bamboo structures, along with the micro, macro- and nano structural properties shutter bamboo concrete slabs, application of bamboo segments as reinforcement of concrete beams, circular columns and pillars in quadratic form of concrete, double–layer spatial and plane truss bamboo structure and special joints between the bamboo elements, which can be easily used for plane and double-layer spatial structures.

It is now well established that bamboo is a composite material of cellulose fibres, with an average tensile resistance of about 700 MPa. These cellulose fibres are

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immersed in a lignin matrix. Studies showed that bamboo is a material with the variation of its physical and mechanical properties in an optimized form, according to the stresses generated due to wind load and its own weight. It has been observed on a macroscopic scale that the distances between the nodes (stiffeners), the diameter and the thickness vary along the total length of the bamboo Culm. The thickness, size and volumetric fraction of fibres vary, becoming more concentrated as they approach the external shell.

This is due to the higher forces applied to the external surface when the bamboo is subjected to bending by wind load. The determination of how the variation of volumetric fracture occurs in the thickness is necessary for applying the theory of composite materials to bamboo, which allows the optimized use of bamboo on engineering sites. This variation of the properties as well as the macro, meso and microscopic characterize the graduate functionality of bamboo. There is on-going research concerned with the structural analysis of bamboo frame structures commonly used by local people, improvement of the concrete permanent bamboo shutter slabs and reinforced concrete beams and columns, having in mind its improvement according to available knowledge. Fabrication of corrugated composite slabs based on cement paste reinforced with cellulose pulp of bamboo. The cement composites reinforced by bamboo pulps are produced by the vacuum pressure process, seeking to establish the characteristics of a material which can be easily fabricated, utilising the machinery of asbestos cement industry. The bamboo pulp is used in the paper industry on a large scale. There are studies underway to produce durable furniture and new geometrical structural forms, as well as bicycles, tricycles and car bodies using bamboo. The first aero plane which succeeded to fly was made with bamboo by the Brazilian Santos Dumont.

COIR FIBER / COCONUT FIBER

FIG A 3 COCONUT FIBER

Coconut fibre is extracted from the outer shell of a coconut. The common name, scientific name and plant family of coconut fibre is Coir, Cocosnucifera and Arecaceae (Coconut), respectively. There are two types of coconut fibres, brown fibre extracted from matured coconuts and white fibres extracted from immature coconuts. Brown fibres are thick, strong and have high abrasion resistance. White fibres are smoother and finer, but also weaker.

Coconut fibres are commercial available in three forms, namely bristle (long fibres), mattress (relatively short) and decorticated (mixed fibres). These different types of fibres have different uses depending upon the requirement. In engineering, brown fibres are mostly used.

According to official website of International Year for Natural Fibres 2009, approximately, 500 000 tonnes of coconut fibres are produced annually worldwide, mainly in India and Sri Lanka. Its total value is estimated at $100 million. India and Sri Lanka are also the main exporters, followed by Thailand, Vietnam, the Philippines and Indonesia. Around half of the coconut fibres produced is exported in the form of raw fibre. A coconut tree, coconut and coconut fibres. Shows the structure (longitudinal and cross section) of an individual fibre cell.

There are many general advantages of coconut fibres e.g. they are moth-proof, resistant to fungi and rot, provide excellent insulation against temperature and sound, not easily combustible, flame-retardant, unaffected by moisture and dampness, tough and durable, resilient, springs back to shape even after constant use, totally static free and easy to clean.

ADVANTAGES OF FIBER COMPOSITES

- As moulded dimensional accuracy. Tight tolerance, repeatable mouldings.
- Chemical Resistance.
- Consolidated Parts and Function.
- Corrosion Resistance.
- Design Flexibility.
- Durable.
- High Flexural Modulus to Carry Demanding Loads. High Impact Strength.
- High Performance at Elevated Temperatures.

EPOXY RESIN

Epoxy Resins Epoxy resins have been commercially available since the early 1950's and are now used in a wide range of industries and applications.

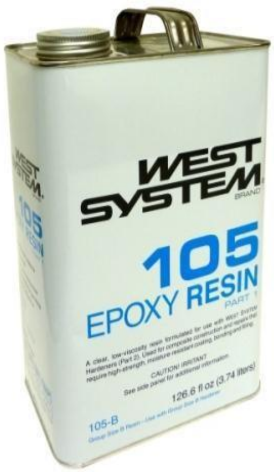

FIG 1.2 EPOXY RESIN

Epoxies are classified in the plastics industry as thermosetting resins and they achieve the thermo set state by means of an addition reaction with a suitable curing agent.

Properties of epoxy and polyester resins.	
Property	Epoxy
Viscosity at 25 °C μ (cP)	12000-13000
Density ρ (g.cm^{-3})	1.16
Heat Distortion Temperature HDT (°C)	50
Modulus of elasticity E (GPa)	5.0
Flexural strength (MPa)	60
Tensile strength (MPa)	73
Maximum elongation (%)	4

TABLE4.4

The curing agent used will determine whether the epoxy cures at ambient or elevated temperatures and also influence physical properties such as toughness and flexibility

PROPERTIES OF EPOXY

The primary reason for epoxy's popularity is its superb mechanical strength. Welding is often the only alternative. Epoxy is nearly always cheaper and faster than welding. Epoxy also has excellent resistance to chemicals. After setting, there is no worry of a chemical reaction that will weaken the seal. It also resists heat. That resistance makes it ideal for electronics and electrical systems and other industrial applications. Those who use epoxy are aware of the superb mechanical strength and low curing contraction. They also know the epoxy resins are well- balanced industrial materials and suited to a broad range of applications. Engineers are faced with concerns about heat dissipation, electrical insulation, adhering dissimilar substrates, light weighting, sound dampening, vibration, and reduction corrosion. Appearance has to be considered, as well as, assembling costs. Epoxy is an adhesive formulation that meets all of those concerns. Its thermal and electrical properties, strength, and durability are what epoxy is noted for. Those properties along with the resistance to immersion and hostile chemical vapor are the reason epoxy often is chosen by engineers.

Performance Properties

Performance properties held by epoxy are:

- Biocompatibility
- Environmentally friendly
- Flame resistant
- Food Safe

It has excellent gap filling properties. Epoxy is resistant to cold, radiation, and steam. The superior performance of epoxy remains when exposed to adverse environmental conditions.

FIBER COMPOSITE MATRIAL PROCESS

DIE MAKING

The tooling involved moulding is quite similar to that of stamping dies. The principal difference is that stamping requires force, while molding does not. In molding, two units are required whose design is such that, when brought together, they make up a system of closed cavities linked to a central orifice. Liquid is forced through the orifice and into the cavities, or molds, and when the solidifies, the molds open and the finished parts are ejected.

MAKING PROCESS

Bamboo and coconut fiber knitted fabric with are used in this study. Hardener used is polyamide hardener. The epoxy resin and hardener are mixed in the ratio of 2:1 and stirred thoroughly. Release agent used was mansion polish. Experimental methods most mentioned method to clean fibers found in literature is distilled water cleaning and then alkaline treatment (NaOH). The concentration of NaOH used is 5%. The fibers are washed with fresh water thoroughly. The fibers are then

soaked in NaOH solution for 8 hours. The fibres were then washed several times with fresh water to remove the residual NaOH sticking to the fibre surface and neutralized by Acetic acid finally washed again with water. The fibers were then dried at room temperature for 10 hours. Removal of lignin, hemi cellulose, silica and pith from the fiber to have better impregnation between fiber and matrix and improving fiber surface roughness to have a better interaction are the main objectives of fiber chemical treatment.

MIXING PROCESS

Two part epoxy compounds are normally supplied in separate A - B containers, either both full or in a pre-measured kit. Under the Resin lab designation; Part A is the epoxy resin and the Part B is the polyamine hardener, with some systems the Part B may be an anhydride. Epoxy resins are normally clear to slightly amber, high viscosity liquids which may be filled with mineral fillers to improve performance and lower cost. These sometimes can settle to the bottom of the container and must be stirred to a homogeneous consistency before adding the hardener. Epoxy resins can cause mild skin irritation and a form of dermatitis upon repeated contact. It is important to limit skin contact with any epoxy resin or hardener. Therefore, we recommend that you wear rubber gloves when mixing and using the epoxy compounds.

APPLICATION

- Automobile components
- Corrosion resisting areas
- Tidal power plant components

CONCLUSION

As a lot of work has been done in designing of leaf springs which is discussed briefly in this text, on the basis of this study, problems in overall weight reduction by using composite materials are identified. Many of the authors suggested various methods of designing, manufacturing and analyses of composite leaf springs. After studying all the available literature it is found that weight reduction can be easily achieved by using composite materials instead of conventional steel, but there occurs a problem during the operation while using the composite leaf spring i.e. chip formation when the vehicle goes off road. Therefore there is an immense scope for the future work regarding use of (**bamboo and coconut fiber**) composite materials in leaf springs to reduce the overall weight of the vehicle as well as the cost of the vehicle.

REFERENCE

Erol Sancaktar and Mathieu Gratton, Design, Gulur Sidd

Analysis and Optimization of Composite Leaf spring for Light Vehicle Application, Elsevier Science Ltd. Vol. 44, 1999, pp195-204.

Mahmood M. Shokrieh, Davood Rezaei,

Analysis and Optimization of a Composite Leaf Spring. Elsevier Science Ltd. Vol. 60, 2003, pp317-32

aramanna Shiva Shankar, Sambagam Vijayaragan, Mono Composite Leaf Spring for Light Weight Vehicle – Design, End Joint Analysis and Testing, Material Science , Vol. 12, April 2006, pp220-225.

Patunkar M. M., Dolas D. R., Modelling and

Analysis of Composite Leaf Spring under the Static Load Condition by using FEA, International Journal of Mechanical & Industrial Engineering, Vol.1, 2011, pp1-4.

Venkatesan M., Devraj D. Helmen, Design and

analysis of composite leaf spring in light vehicle, International Journal of Modern Engineering Research, Vol. 2, Jan-Feb2012, pp213-218.

Shishay Amare Gebremeskel. Design,

Simulation, and Prototyping of Single Composite Leaf Spring for Light Weight Vehicle. Global Journal of Research in Engineering Mechanical and Mechanics Engineering, Vol. 12, 2012, pp21- 30.

Kumar Y. N. V. Santosh and Teja M. Vimal,

International Journal of Mechanical and Industrial Engineering, Vol. 2, 2012, pp97-100. 8. Jadhav Mahesh V., Zoman Digambar B, Y. R. Kharde and R. R. Kharde, Performance Analysis of Two Mono Leaf Spring used for Maruti 800 Vehicle, International Journal of Innovative Technology and Exploring Engineering, Vol. 2, December 2012, pp65-67