Some investigations on natural composites for chassis

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ABSTRACT

Natural fibres have attracted the researchers for their low cost, ease of availability, high tensile strength, low thermal expansion, high strength to weight ratio and bio-degradability. The present work aims at developing hybrid natural fibres based polymer composite material. The reinforcement used are powdered aleovera and sugarcane bagasse with epoxy resin as a matrix. The specimens were prepared by changing volume fraction and were tested for mechanical properties such as tensile, flextural and impact energy and water absorption. The present result would be helpful in developing new natural hybrid composites.

1. INTRODUCTION

Now-a-days many original equipment manufacturers (OEMs) are launching new variants every quarter and others are lining up fast. Virtual testing or CAE has proven its importance in such competitive environment. New product development program involves the design and development of various aggregates like chassis, body, suspension, power- train etc. To meet the stringent product targets requirements in terms of time, weight and cost various design iterations with what/if scenarios needs to be studied. Global aggressive competition has forced Auto-OEM's to reduce the product development time. CAE tools are widely used in the automotive industry to reduce product development cost and time while improving the safety, comfort, and durability of the vehicles.

Commercial vehicle chassis frame is a ladder type construction used as a base structure to mount all the aggregates to build a vehicle. In field, the chassis is subjected to various static and dynamic loadings and should perform well without failure. As a part of frame Design Validation Plan (DVP) Service Load Analysis (SLA) is one of the important steps. Service loads are the peak load values corresponding to field events like bump, braking, cornering, twisting etc. Setting up the FE model for SLA and its deck preparation is manual, error-prone and time consuming process. One of the ways to make process error free is automation of these CAE processes.

Automotive chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies, brakes, steering etc. are bolted. The chassis is considered to be the most significant component of an automobile. It is the most crucial element that gives strength and stability to the vehicle under different conditions. Automobile frames provide strength and flexibility to the automobile. The backbone of any automobile, it is the supporting frame to which the body of an engine, axle assemblies are affixed. Tie bars, that are essential parts of automotive frames, are fasteners that bind different auto parts together.

Automotive frames are basically manufactured from steel. Aluminium is another raw material that has increasingly become popular for manufacturing these auto frames. In an automobile, front frame is a set of metal parts that forms the framework which also supports the front wheels. It provides strength needed for supporting vehicular components and payload placed upon it. Automotive chassis is considered to be one of the significant structures of an automobile. It is usually made of a steel frame, which holds the body and motor of an automotive vehicle. More precisely, automotive chassis or automobile chassis is a skeletal frame on which various mechanical parts like engine, tires, axle assemblies; brakes, steering etc are bolted. At the time of manufacturing, the body of a vehicle is flexibly molded according to the structure of chassis. Automobile chassis is usually made of light sheet metal or composite plastics. It provides strength needed for supporting vehicular components and payload placed upon it. Automotive chassis or automobile chassis helps keep an automobile rigid, stiff and unbending. Auto chassis ensures low levels of noise, vibrations and harshness throughout the automobile.

2. LITERATURE REVIEW

A composite is a material made by combining two or more dissimilar materials in such a way that the resultant material is endowed with properties superior to any of its parental ones. Fiber-reinforced composites, owing to their superior properties, are usually applied in different fields like defense, aerospace, engineering applications, sports goods, etc. Nowadays, natural fiber composites have gained increasing interest due to their eco-friendly properties. A lot of work has been done by researchers based on these natural fibers. Natural fibers such as jute, sisal, silk and coir are inexpensive, abundant and renewable, lightweight, with low density, high toughness, and biodegradable. Natural fibers such as aloevera have the potential to be used as a replacement for traditional reinforcement materials in composites for applications which requires high strength to weight ratio and further weight reduction. Bagasse fiber has lowest density so able to reduce the weight of the composite upto very less. So by using these fibers (aloevera, and bagasse) the composite developed is cost effective and perfect utilization of waste product.

Natural fiber reinforced polymer composites have raised great attentions and interests among materials scientists and engineers in recent years due to the considerations of developing an environmental friendly material and partly replacing currently used glass or carbon fibers in fiber reinforced composites. They are high specific strength and modulus materials, low prices, recyclable, easy available in some countries, etc

Yan Li et al [14] conducted a research to study the poor interfacial bonding between the hydrophilic natural fibers and the hydrophobic polymer matrices. Two types of fiber surface treatment methods, namely chemical bonding and oxidization were used to improve the interfacial bonding. Interfacial properties were evaluated and analyzed by single fiber pull-out test and the theoretical model. Based on this study, an improved method which could more accurately evaluate the interfacial properties between natural fiber and polymeric matrices was proposed.

N.Venkateshwaran et al [11] In their work showed the tensile strength and modulus of short randomly oriented natural fiber hybrid composites were predicted using the Role of Hybrid Mixture (RoHMs) equation. This equation values little higher than the experimental values, this method is easiest way to predict the tensile properties of hybrid composites when compare with Halpin Tsai model, Hirsch models.

D. Ray et al [5] In their work showed that the use of compatibilizer in jute fibers increases its mechanical properties. At 60% by weight of fiber loading, the use of the compatibilizer improved the flexural strength as high as 100%, tensile strength to 120%, and impact strength by 175%.

Mohd Suhairil Meon et al [9] from this paper proved that the alkalization treatment has improved the tensile properties.6%of NaoH yields the optimum concentration of the NaoH chemical treatment.

Monteiro SN. Rodriquez et al [10] tries to use the sugar cane bagasse waste as reinforcement to polymeric resins for fabrication of low cost composites. They reported that composites with homogeneous microstructures could be fabricated and mechanical properties similar to wooden agglomerates can be achieved.

Hassan et al [6] has converted the bagasse into a thermo formable material through etherification of the fiber matrix. The dimensional stability and mechanical properties of the composites prepared from esterifies fibers were reported in this work.

BC Ray et al [3] used 3-point flexural test to qualitatively assess such effects for 55, 60 and 65 weight percentages of E-glass fibers reinforced epoxy composites during cryogenic and after thawing conditions. The specimens were tested at a range of 0.5 mm/min to 500 mm/min crosshead speed to evaluate the sensitivity of mechanical response during loading at ambient and sub-ambient (- 80°C temperature). These shear strength values are compared with the testing data of as-cured samples. After reviewing the existing literature available on natural fiber composites, particularly natural fibers (jute, bagasse and lantana camara) composites put efforts to understand the basic needs of the growing composite industry. The conclusions drawn from this is that, the success of combining vegetable natural fibers with polymer matrices results in the improvement of mechanical properties of the composites compared with the matrix materials. These composite fibers are cheap and nontoxic, can be obtained from renewable sources, and are easily recyclable. Moreover, despite their low strength, they can lead to composites with high specific strengths because of their low density.

S.V.Joshi et al [13] compared life cycle environmental performance of natural fiber composites with glass fiber reinforced composites and found that natural fiber composites are environmentally superior in the specific applications studied. Natural fiber composites are likely to be environmentally superior to glass fiber composites in most cases for the following reasons: (1) natural fiber production has lower environmental impacts compared to glass fiber production; (2) natural fiber composites have higher fiber content for equivalent performance, reducing more polluting base polymer content; (3) the light-weight natural fiber composites improve fuel efficiency and reduce emissions in the use phase of the component, especially in auto applications; and (4) end of life incineration of natural fibers results in recovered energy and carbon credits.

A.K.Rana et al [1] in their work showed that the use of compatibilizer in jute fibers increases its mechanical properties. At 60% by weight of fiber loading, the use of the compatibilizer improved the flexural strength as high as 100%, tensile strength to 120%, and impact strength by 175%. The following conclusions may be drawn from this paper:

1. The sharp increase in mechanical properties and decrease in water absorption values after addition of the compatibilizer.

2. All these results justify that the role of jute fiber was not as a filler fiber but as a reinforcing fiber in a properly compatibilized system.
3. This system produced a new range of low-energy, low-cost composites having interesting properties and should be given priority over costly and high-energy synthesis reinforcing fiber wherever possible.

A.N.Shah and Lakkad et al [2] tries to compare the mechanical properties of jute-reinforces and glass-reinforced and the results shows that the jute fibers, when introduced into the resin matrix as reinforcement, considerably improve the mechanical properties, but the improvement is much lower than that obtained by introduction of glass and other high performance fibers. Hence, the jute fibers can be used as reinforcement where modest strength and modulus are required.

Another potential use for the jute fibers is that, it can be used as a filler fiber, replacing the glass as well as the resin in a filament wound component. The main problem of the present work has been that it is difficult to introduce a large quantity of jute fibers into the JRP laminates because the jute fibers, unlike glass fibers, soak up large amount of resin. This problem is partly overcome when „hybridsing" with glass fibers is carried out.

Ray et al [3] in their work, Jute fibers were subjected to alkali treatment with 5% NaOH solution for 0,2,4,6 and 8h at 300C. It was found that improvement in properties both for fibers and reinforced composites. The fibers after treatment were finer, having less hemicellulose content, increased crystallinity, reduced amount of defects resulting in superior bonding with the vinylester resin. As fibers, the improvements in properties were predominant around 6–8 h treatment whereas as composites, it was maximum when reinforced with 4 h-treated fibers at 35% fiber loadings. The modulus of the jute fibers improved by 12, 68 and 79% after 4, 6 and 8 h of treatment, respectively. The tenacity of the fibers improved by 46% after 6 and 8 h treatment and the% breaking strain was reduced by 23% after 8 h treatment. For 35% composites with 4 h-treated fibers, the flexural strength improved from 199.1 to 238.9 MPa by 20%, modulus improved from 11.89 to 14.69 GPa by 23% and laminar shear strength increased from 0.238 to 0.283 MPa by 19%. On plotting different values of slopes obtained from the rates of improvement of flexural strength and modulus, against NaOH treatment time, two different failure modes were apparent before and after 4 h of NaOH treatment.

3. MATERIALS SELECTION

3.1 Raw materials

- ✓ Reinforcement-aloevera and sugarcane
- ✓ Matrix-epoxy resin

3.1.1 Reason for choosing fibers

Sugarcane fiber - While a tree takes years to grow, plants with short development cycles such as **sugarcane** are very attractive for composite reinforcement and this is even truer of sugarcane bagasse, being a waste by-product of sugar plants.

Araldite epoxy resin - Araldite resin belong to **epoxy** group which have excellent thermal and physical properties, and usually used in composite materials for different application, where it distinct by excellent adhesive capability especially to fibers, also it retain constant dimension after dryness.

Aloevera fiber - The impact value of the **Aloevera fiber** was comparatively lesser due to the fact that it has higher bond strength at the interface between the fiber and the matrix.

3.2 Concentration of sample preparation

For the preparation of the composite, we calculate the percentage of fibers, polymer and hardener required. We come to know about the amount accurately from the table.

Aloevera fiber	**Sugarcane bagasse**	**Epoxy resin**
20	20	60

4. FABRICATION

1. Aloevera and sugar cane fibers were cut into small pieces and mixed with epoxy resin.
2. Then the mixed substance is poured into a die of 100*150mm of cross section.
3. Then the substance is spread equally throughout the entire surface.
4. This is then kept under a load of 100kg.

4.1 Fabrication of composite material

5. TESTING OF MECHANICAL PROPERTIES

5.1 Tensile strength test

The composite samples were tested in the universal testing machine (UTM) and stress-strain curve was plotted. The typical graph generated directly from machine for tensile test for composite.

Fig 5.1 Experimental set up for tensile test

5.2 Flexural strength test

The composite samples are tested in the universal testing machine (UTM) and stress-strain curve is plotted. The typical graph generated directly from machine for flexural test for composite. Flexural properties of different composite samples are tested and results are plotted.

Fig 5.2 Three point bend test loading arrangement

5.3 Impact strength test

The impact test is a method for evaluating the toughness and notch sensitivity of engineering materials. It is usually used to test the toughness of metals, but similar tests are used for polymers, ceramics and composites. Metal industry sectors include Oil and Gas, Aerospace, Power Generation, Automotive, and Nuclear. The notched test specimen is broken by the impact of a heavy pendulum or hammer, falling at a

Fig 5.3 Experimental set up for Impact strength test

-predetermined velocity through a fixed distance. The test measures the energy absorbed by the fractured specimen.

6. TEST RESULTS

In our project is four different methods of the plats is formed and testing the materials.

- Flexural Strength
- Tensile Strength
- Impact Strength
- Water Absorption

6.1 Flexural Strength

The samples possess good flexural strength and can withstand the strength up to 38.541 MPa.

6.2 Tensile Strength

The composite samples were tested in the universal testing machine (UTM) and stress-strain curve was plotted. The typical graph generated directly from machine for tensile test for composite. The samples possess good tensile strength and can withstand the strength up to 15.431 MPa.

6.3 Impact Strength

For analyzing the impact property of the different specimens an impact test is carried out. Impact test carried out for the present study is Charpy impact test. The energy loss is obtained from the Charpy impact machine. The impact response in Glass composites of Charpy impact test is presented. The results indicated that the maximum impact strength is obtained below. The samples possess good impact strength and can withstand the strength up to 0.35 J.

6.4 Water absorption

The samples possess good water absorption and can withstand the strength up to 1.06 %.

S.NO	TEST RESULT	RESULT
1	Flexural strength(MPa)	38.541
2	Tensile strength(MPa)	15.431
3	Impact strength(J)	4.5

4	Water absorption(%)	1.06

7. RESULTS AND DISCUSSIONS

7.1 Impact test comparison

S.NO	SPECIMEN	IMPACT STRENGTH(J)
1	Bamboo epoxy resin composite	3
2	Bamboo-Jute epoxy resin composite	4
3	Bamboo-Coir epoxy resin composite	5
4	Aloevera-sugarcane epoxy resin composite	4.5

7.2 Conclusion

A chassis, being the frame of the vehicle has to be rigid or strong to absorb and retain movements and vibrations from the engine, suspension and axles. It should also be as light as possible to improve the vehicle's performance and fuel efficiency. Composite materials which reduce the weight compared to the traditional aluminum and steel solutions. In the view of fuel economy the natural fiber are given extreme output. The crushed medium density of hybrid natural fiber aloevera and sugarcane is help to fabricate of large composite components.

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