

Fabrication and Analysis of Sisal / Carbon Fibers Composite Wheel Rim

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Abstract

Alloy wheels are often composed of aluminum or magnesium metal or a combination of two metals. Usually, an alloy wheel made of magnesium or aluminum metal or sometimes a mixture of these two metals. Because the alloy wheel is lightweight, the vehicle speed is faster, but it is different from regular steel, but some alloy wheels are heavier than steel wheels of the same size. In automotive design, the industry searches for polymer composites as the best material for replacing aluminum alloys without significantly reducing the quality and reliability of the vehicle. Use of this material achieves quality optimization. In this project work, we are considering aluminum and composite fiber (carbon + sisal) rims. This article is about static analysis of aluminum and composite rims. By applying different loads and pressures, the entire wheel design of the two-wheeler is modeled and analyzed. The Al alloy wheel configuration of a two wheeler was selected for the investigation. Finite element analysis has been performed using ANSYS software to determine safe stress and displacement. For aluminum and composite materials, the goal is to determine stress, strain, and deformation using force as the boundary condition. A safety factor was later identified by using force as the boundary condition for these aluminum and composite materials. The pressure used as the boundary condition then reveals the stress, strain, and deformation of these composite materials and aluminum. Comparing these results, these results clearly show that mixed fiber material (carbon + sisal) is used as the best choice and can replace aluminum alloy with its good mechanical properties. Compared with aluminum alloy, hybrid composite material has a good safety factor value.

Keywords: Carbon Fiber, Sisal Fiber, Wheel Rim, Aluminum Alloy, ANSYS.

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INTRODUCTION

One of the most important factors for technical advancement and innovation is population increase.

Composite materials are mostly utilised to replace traditional materials in the building and automotive industries. Composite materials offer for increased mechanical qualities in addition to cost and weight reduction.

A vehicle's wheel is an essential component. Today's archaeologists and historians look at the introduction of viewing the wheel as the true origin of any ancient civilization. The wheel is arguably the most important invention of all time. The wheel is the enabling motion that is overcome by the rolling of the axle friction. Aluminum alloys, magnesium alloys, and steel are used to make wheel rims. Titanium is also utilized to make some automobile

rims.

The loading circumstances influence the design of the wheel rim. The modern automobile is also a fashion item that caters to people's specific needs. Vehicles are now manufactured under very rigorous guidelines to ensure passenger safety. Every component is designed in accordance with its criticality. Wheels are categorized as a safety vital component, with worldwide rules and criteria for wheel design. Wheels for automobiles are changing. Over the years, we've evolved from early wood and steel spoke designs. A vehicle's handling is always improved by reducing its weight. The smaller the unsprung weights are, the easier it is to control the motion of the tyre wheel and improve adhesion to the road surface. Some wooden automobile wheels had a detachable steel rim bolted to the wooden wheel's outer circumference.

OBJECTIVES

The authors fabricated wheel rim made up of hybrid composite material for a two wheeler. The composite materials used here are sisal fiber (natural fiber) and carbon fiber (synthetic fiber). The Composite material was fabricated and modeled using CATIA software and analyzed using ANSYS 16.2 Software. Authors performed Finite element analysis on hybrid composite wheel rim. They found out mechanical properties of Composite wheel rim and compared those values with aluminum alloy wheel rim using ANSYS software. The values of stress, deformation and strain of aluminum alloy by applying force as the boundary condition noted and compared these values with composite wheel rim. The value of factor of safety has also been noted by applying force as boundary condition for both aluminum alloy and composite material. The values of stress, deformation and strain of aluminum alloy by applying pressure as boundary condition noted and compared values of stress, deformation and strain of hybrid composite materials.

LITERATURE REVIEW

Damage Analysis of Hybrid Composites Prepared Using Industrial Waste by V Arumugprabhu, Tae jo ko, R Deepak joel Johnson [1] is a hybrid composite with and without fillers from industrial waste. We conducted a detailed investigation into material breakage analysis. Various matrix materials, reinforcement materials, manufacturing processes, and analytical methods have been used to develop highly effective composites.

Development of Carbon fiber wheel rims for formula student racing car (2019) of BH Dhage, sonali shah and Nakul Shiledar demonstrates that in order to increase vehicle performance and efficiency, the vehicle's mass must be lowered. Making the wheels out of a woven carbon fiber composite is a good way to go. This approach has been used by well-known firms such as Mercedes and BMW to lower the weight of other automobiles.

T. Siva Prasad *et al.* (2014) investigated the qualities of several types of wheel rims, as well as the benefits and drawbacks of different materials such as aluminum, magnesium, carbon fiber, steel, and others. He compared static displacement, von Mises stress, and dynamical displacement in aluminum and forged steel.

FABRICATION OF WHEEL RIM

A. Hand lay-up technique

Hand lay-up is the maximum generally used open mould composite production process. Initially fiber plays are positioned in a mould wherein a skinny layer of anti-adhesive coat is carried out for smooth extraction. The resin cloth is poured or carried out the use of the comb on a

reinforcement cloth. The curler is used to pressure the resin in to the fabric to make a stronger interplay among the successive layers of the reinforcement and matrix materials. The hand layup of pre-impregnated Woven substances remains a bigger part of the composite production industry, requiring the talents and revel in of the human paintings pressure to shape flat plies in to complicated shapes. It is able to generating excessive overall performance and complicated elements however may be high priced and variable manner.

Manual work is the oldest and best technique for manufacturing reinforced plastic laminates. The capital of the apportionment method is very small. The most expensive part of a traditional system is a spray gun for applying resin and gel coat. Some manufacturers pour or brush the resin into a mold to eliminate the need to use a spray gun at this step. There are actually no restrictions on the dimensions of the items that can be manufactured. Molds can be made of wood, sheet metal, plaster and GRP composites.

SISAL / CARBON MOULD PREPARATION MAINTAINING THE INTEGRITY OF THE SPECIFICATIONS

For the production of carbon fiber wheel rim molds, carbon fiber composite materials and composite materials based on thermosetting resin are manufactured, molds are made, and carbon fiber composite materials are put into molds to enable carbon fibers. Includes steps to do. The wheel rims are in shape accordingly.



Fig. 1. Model preparation and adding epoxy resin



Fig. 2. Pasting carbon fiber to the rim and final product

FINITE ELEMENT ANALYSIS OF WHEEL RIM

A. Modelling of wheel rim

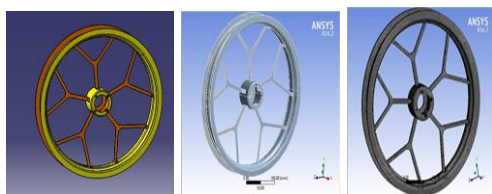


Fig. 3. Cad model, Cad model imported to ANSYS and Mesh generated model

B. Tabulation of Loads and Pressures

The weight of the two-wheeled vehicle used in the experiment is assumed to be 163 kg. For a load 0, the author considered the total weight of the vehicle to be 163 kg. That is, 1599.03 N. For load 1, the author also took into account the weight of the driver. The average weight of the driver is assumed to be 60 kg. So with a load 1, the total weight of the vehicle is 223 kg, or 2187.63 N. For load 2, authors considered the weight of the Pillion passenger as well as the weight of the driver. The average weight of the pillion is assumed to be 60 kg. So with a load 2, the total weight of the vehicle is 283 kg, or 2776.23 N.

TABLE I: TABLE TYPE STYLES

No. of Loads	N	No. of Pressures by Load	N/mm ²
Load 0	1599.03	Pressure 0	0.0377
Load 1	2187.63	Pressure 1	0.0516
Load 2	2776.23	Pressure 2	0.0655

ANALYSIS

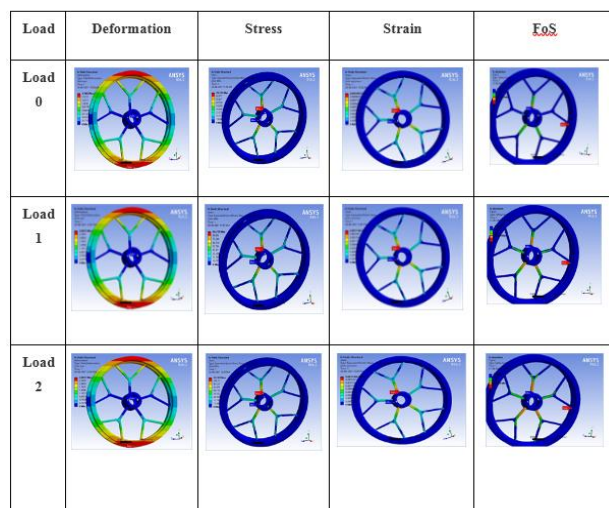


Fig. 4. Load analysis of Aluminum alloy using Ansys

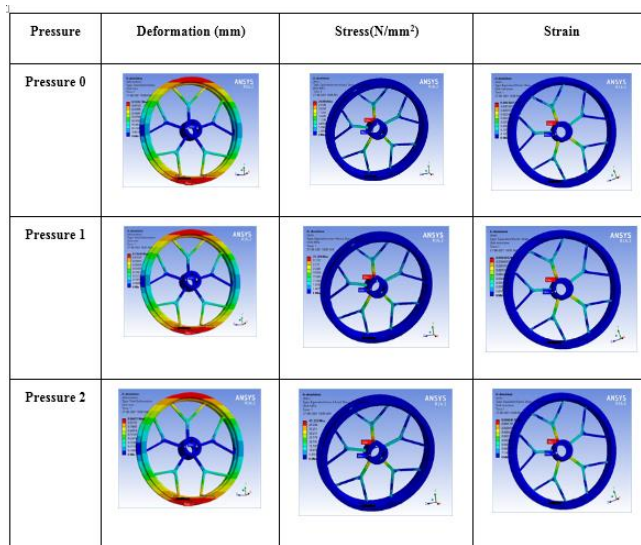


Fig. 5. Pressure analysis of Aluminum alloy using Ansys

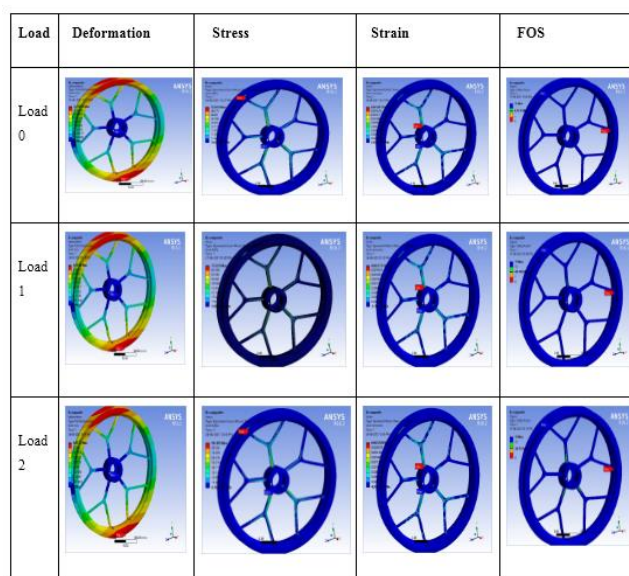


Fig. 6. Load analysis of Sisal / Carbon Fibers using Ansys

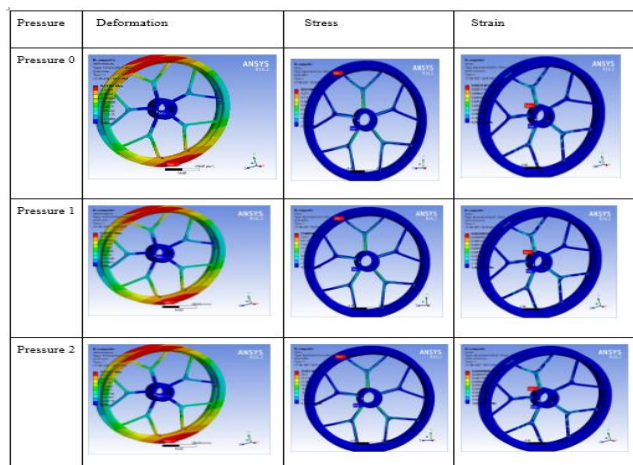


Fig. 7. Pressure analysis of Sisal / Carbon Fibers using Ansys

RESULTS AND CONCLUSION

TABLE 2. COMPARISON OF ALUMINIUM AND SISAL/CARBON MATERIALS BASED ON LOAD

Material	Force (N)	Factor of Safety	Deformation (mm)	Stress (MPa)	Strain
Aluminum	1599.03	3.9583	1.5443	70.737	0.0010003
	2187.63	2.8933	2.1128	96.775	0.0013684
	2776.23	2.2799	2.6812	122.81	0.0017366
Composite Material	1599.03	6.7232	0.37855	52.059	0.0015913
	2187.63	4.9142	0.51789	71.222	0.002177
	2776.23	3.8723	0.65723	90.385	0.0027628

TABLE 3. COMPARISON OF ALUMINIUM AND SISAL/CARBON MATERIALS BASED ON PRESSURE

Material	Pressure (N/mm ²)	Deformation (mm)	Stress (MPa)	Strain
Aluminum	0.0377	0.55267	26.086	0.000369
	0.0516	0.75644	35.704	0.00050528
	0.0655	0.960211	45.322	0.00064139
Composite Material	0.0377	0.1356	18.914	0.00057493
	0.0516	0.18561	25.888	0.0007869
	0.0655	0.23561	32.861	0.00099888

The Maximum values of Stresses, Strain and Displacements of Aluminum Alloy and Carbon + Sisal fiber composite material for various types of loads and Pressures were analyzed and tabulated. Based on the above observations we concluded that this Hybrid Fiber Composite Material minimizes the failure and increases the life time. While comparing the results concluded that this Hybrid Composite material is the suitable material for the commercial two wheeler vehicles for respective design.

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