JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

FEA ANALYSIS AND IMPLEMENTATION OF COMPOSITE TWO-WHEELER FRAME FOR E-BIKE

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ABSTRACT

It has been discovered that composites are the most promising and discerning material available in this century. Composite materials reinforced with synthetic or natural fibres have recently gained prominence as the market seeks lighter materials with higher strengths for specific applications. High strength-to-weight ratio apart, fiber-reinforced polymer composites show excellent qualities such as long durability, stiffness, damping property, flexural strength and resistance to corrosive, wearable, impactful and fire-resistant elements. Composite materials have found use in a broad variety of manufacturing fields due to their versatile properties, which include mechanical, construction, aerospace, automotive, biomedical, and marine. The use of electricity as a fuel source powers electric motorcycles. For mobility, many people prefer e-bikes because of their eco-friendliness and economic efficiency. The best design for an electric bike frame is modelled and assessed for static and vibration analyses in this study. The bike's frame serves as the bike's skeleton, supporting and securing the bike's weight. An electric bike frame made from steel, composite, composite reinforced with sugarcane (prosopis juliflora) is the primary goal of this project. As a result of the composite's light weight, strength, safety, and cost-effectiveness. AISI-certified materials are used. Static and vibrational analysis were used to examine the frame's components in the event of rapid collisions. The design of e-bikes is modelled and analysed using a variety of materials and their compositions, it is concluded. The results could be compared to current materials.

INTRODUCTION

Indian roads are among the busiest in the world, with a population of more than 1.2 billion people. A major cause of death in this country is the high number of accidents caused by the sheer size of the country's population. 1.47 lakh people are killed on the roads of India every year, which is one death every four minutes and an average of 1200 accidents every day. More than a third of all road deaths are caused by two-wheeler accidents. For the sake of the rider's safety, the frame of the bicycle should be carefully scrutinised. As the bike's skeleton, the frame takes the heaviest loads and supports all of the bike's key components and systems. The frame serves as a support for many components, giving each one the strength it needs to carry its own weight. Other components supported by the frame include the seat, bodywork, and other add-ons. The frame serves as a mounting point for the battery and engine as well. Shocks and collisions from the vehicle must be absorbed by the frame, which must be strong and rigid in order to safeguard the occupants and other critical components of the vehicle. The transmission, steering, and suspension all influence the design of the frame. Several elements influence the outcome of the investigation. Impact and weight analysis are the two aspects we've taken into account from this list. To be effective, a design must be both cost-efficient and safe, even when subjected to high loading. All loads and effects must be taken into account while creating the design. As a result, we may learn about the frame's state during an impact through analysis.

As the price of fossil fuels rises and the amount of greenhouse gas emissions rises, we must discover a mode of transportation that is both affordable and environmentally beneficial. Electric-powered vehicles are becoming increasingly popular in this setting. In today's world, electric vehicles are both economical and beneficial to the environment. Cycling is a popular means of transportation for short distances among the general population. However, its inability to be carried around is a huge drawback. Instead of light frames, the majority of the bicycles sold in India feature heavy steel frames. As a result, transporting it is a hassle. Designing and building a lightweight foldable bike is the answer to this dilemma. The addition of an electrical system broadens the scope of the device's use even further. A foldable electric bike has an electric motor built into the frame, making it convenient to travel and store. It makes it possible for users to fit in a little bit of physical activity into their daily commutes, which promotes good health. Using a folding electric bike is a convenient way to go around.

SCOPE OF THE WORKS

Fuels are burned to provide energy that can be used for movement. Unburned hydrocarbons or other components in the fuel or air during combustion are the source of pollution. Carbon dioxide, the major greenhouse gas, is released as a byproduct of combustion. Cities and regions use a wide range of fossil fuels in their transportation systems. Transport sector emissions are affected by numerous factors, and a successful approach will need to take into account all of them. All of these things are included in the data set, which includes information on how many vehicles are used in a particular country or metropolitan area; how old the vehicle is; how well it is maintained; the availability of the right fuels and the extent to which they are used; and environmental, climatological, and topographical conditions in the area.

AIM & OBJECTIVES

Following were the objectives decided for achieving this aim:

- To study and effectiveness of electric bike
- To design and analysis of frame for electric bike
- To investigate the static and vibrational analysis of two-wheeler frame with convention and polymer composite with natural fibres.
- To provide a mode of transport which more user friendly and effortless.

NECESSITY OF ELECTRIC - BIKE

They get you to places faster than the average speed of traffic

It's possible that this seems ridiculous at first, but after some consideration, the average city inhabitant will realise that this argument is correct. At peak times, traffic moves at a snail's pace because of the many bottlenecks that we encounter on a daily basis. Electric bikes provide numerous advantages in this case. Using an e-bike will get you to your destination faster than using a conventional bicycle or a car.

COMPOSITE MATERIALS: AN OVERVIEW

For a plane to be more efficient, it needs to be strong, rigid, and light. Metals and alloys, as well as other conventional materials, could only meet these requirements to a limited extent. Consequently, new materials with superior qualities to standard metals and alloys have to be created.

Macroscopically joined components of two or more constituents make up a composite structural material. A composite material consists of a matrix and a reinforcement, both of which are discrete.

NATURAL COMPOSITE

Wood: Cellulose fibers bound by lignin matrix

Bone: Stiff mineral "fibers" in a soft organic matrix permeated with holes filled with liquids

MAN-MADE COMPOSITES

Plywood: Several layers of wood veneer glued Together

Plastic matrix reinforced by glass fibers

Polymer matrix composites are the most widely utilised advanced composites. Thin-diameter fibres such as carbon or aramids are used to strengthen a polymer such as epoxy or urethane in these composites. Their great strength, low cost, and ease of production make them a popular choice for aircraft structure repair.

Both the specific modulus and the specific strength are frequently used to evaluate a composite's relative mechanical advantage. Composites have large ratios of these two parameters.

A single lamina is the building block of a laminate. Consequently, a laminate's mechanical analysis comes first. Non-homogeneous lamina material is anisotropic. The determination of average attributes is based on the individual mechanical properties of fibre and matrix, as well as fibre content, packing geometry, and form, however a lamina is assumed to be homogenous for approximate macro-mechanical analysis. Three Young's moduli, three Poisson's ratio, and three shear moduli may be calculated for each plane of the lamina since it is orthotropic. As a result, the lamina can be described by nine separate elastic constants. Once the properties of each lamina are known, the properties of a laminate made up of those laminae can be determined.

It is more efficient to use composites in the competitive aviation business. Reduced assembly complexity and fuel savings offset any increase in material costs, allowing for a better profit margin. It also reduces the aircraft's weight without sacrificing its structural integrity.

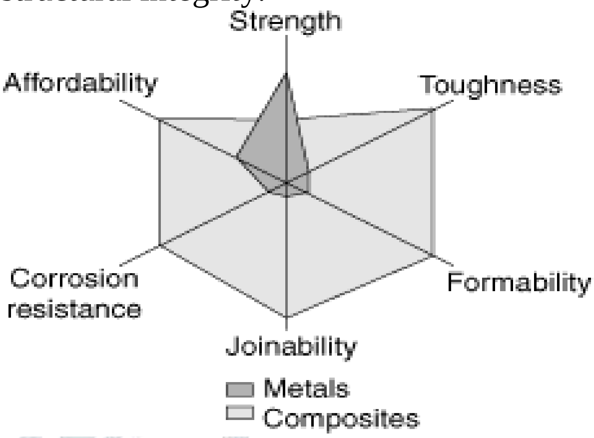


Figure 1. Primary Material Selection Parameter for A Hypothetical Situation For Metal And Composite

BASIC COMPOSITE THEORY

Laminate composites have seen an increase in recent years in such lightweight and high strength structures as ground transportation vehicles, aerospace and spacecraft.. But composite material has a significant drawback. Their ability to withstand impact loads is the most important of these characteristics. When a foreign object impacts a building, it generates an impact force. A dropped tool on a car bonnet cover, a bird strike on an aircraft engine, and debris from the runway are all examples of impact loads. Compound materials, in their most basic form, are those made up of more than one element that interact together to provide material qualities that are distinct from those attributes of the individual elements themselves. However, in real life, the bulk material (the "matrix") is usually reinforced with some sort of material to give it more strength and stiffness. Fibers are the most common kind of this reinforcement.

REINFORCING

Strength and rigidity are provided through reinforcement, and the thermal expansion coefficient is regulated by it. It also aids in the development of directional characteristics.. Fibers, particles, and flakes can all be used as reinforcements. The length, orientation, shape, and substance of the fibres in a composite are all elements that influence its mechanical performance.

CLASSIFICATIONOF COMPOSITE

Composites are classified by

1.geometry of the reinforcement as particulate, structural and fibers

2.the type of matrix as polymer, metal and ceramic

composites can be categorized into three groups on the basis of matrix material. They are:

Metal Matrix Composites (MMC)

Ceramic Matrix Composites (CMC)

Polymer Matrix Composites (PMC)

MODEL AND ANALYSIS

CATIA:CAD/CAM/CAE software CATIA is one of the world's most widely used and well-known programmes. To do this, SolidWorks combines parametric features with two-dimensional tools and addresses the entire design-to-manufacturing process.

CATIA- Computer **A**ided **D**imensional **I**nteractive **A**pplication**.**

CATIA, developed by Desalt systems, France, is a completely re-engineered, next generation family of CAD/CAM/CAE software solution.CATIA serves the basic design task by providing different workbenches, some of the workbenches available in this package are Part design workbench:

1.Assembly design workbench

2.Drafting workbench

3.Wireframeandsurfacedesign workbench

4.Generative shape design workbench

5.DMU kinematics

6.Manufacturing

7.Mold design

PART DESIGN WORKBENCH

The component workbench is a parametric and feature-based platform in which solid models can be created. The sketch-based features are a set of tools in the component design workbench that allow us to convert designs into other features.

ASSEMBLYDESIGN WORKBENCH

The assembly design workbench is used to assemble the part by using assembly constraints. There are two type of assembly design,

1.Bottom –up

2.Top- down

In bottom –up assembly, the parts are create in part workbench and assembled in assembly workbench.

Inthetop-downworkcreated in assembly workbench itself.

Figure2: Model of Frame

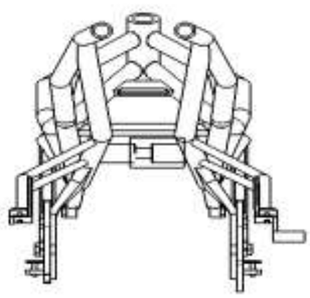


Figure 3: Model of Frame

ANALYSIS RESULTS

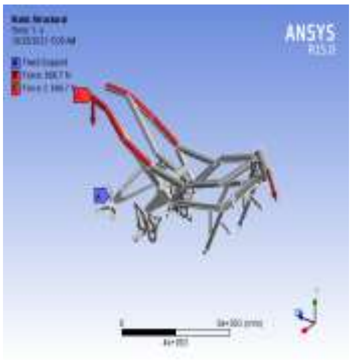


Figure 4: Mesheel Model

STEEL:

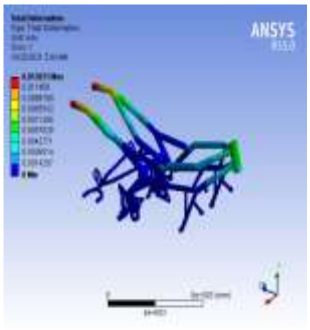


Figure 5 : Total Deformation

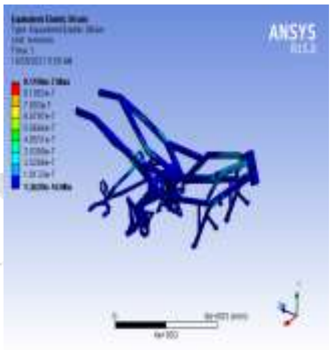


Figure 6 : Equivalent Elastic Strain

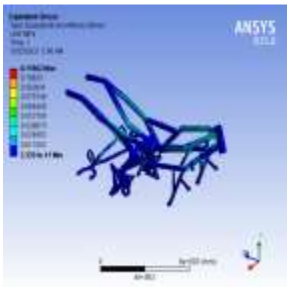


Figure 7 : Equivalent Stress

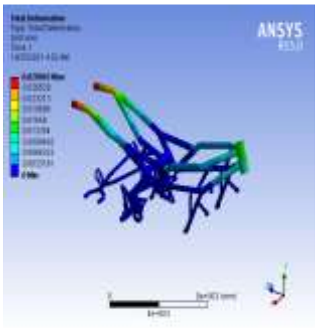


Figure 8 : Total Deformation

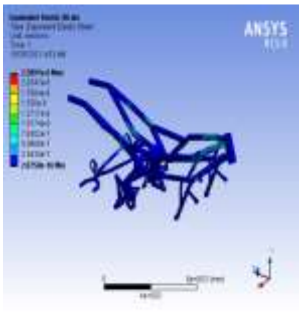
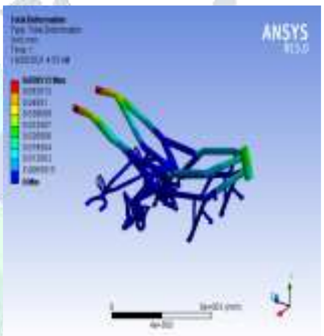


Figure 9 : Equivalent Elastic Strain



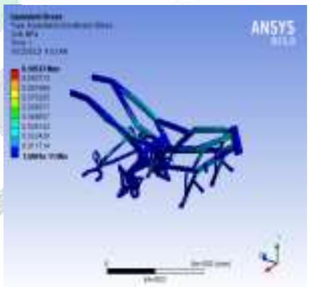


Figure 10: Equivalent Stress

GFRP WITH SUGARCANE FIBER

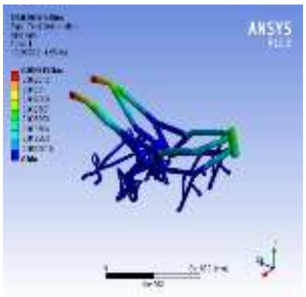


Figure11:Total Deformation

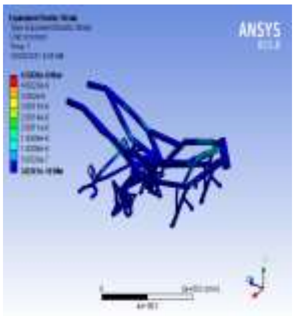


Figure12:Equivalent Elastic Strain

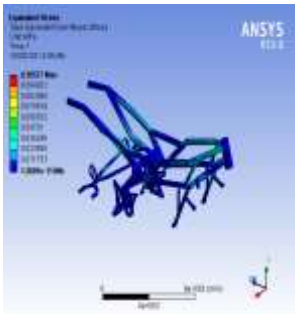


Figure 13: Equivalent Stress

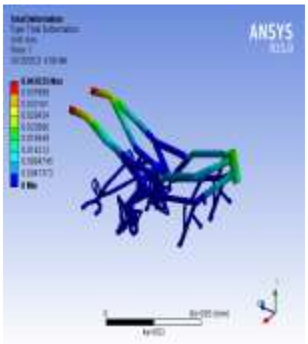


Figure 14:Total deformation

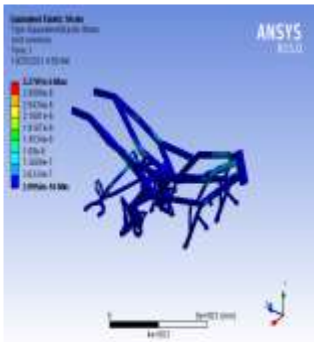


Figure 15: Equivalent Elastic Strain

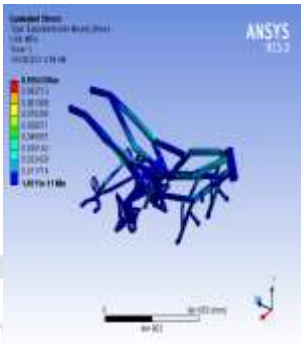


Figure 16 : Equivalent Stress

GFRP WITH EGG SHELL :

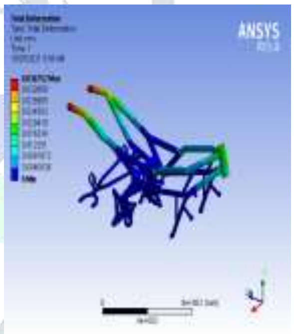


Figure17:TotalDeformation

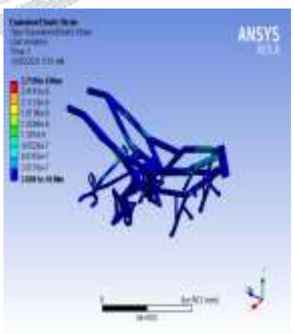


Figure18: Equivalent Elastic Strain

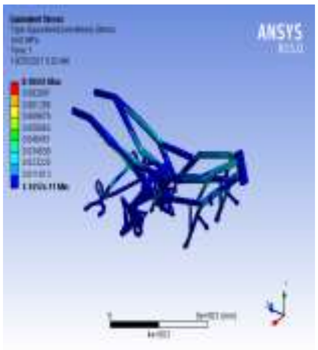


Figure 19 :Equivalent Stress

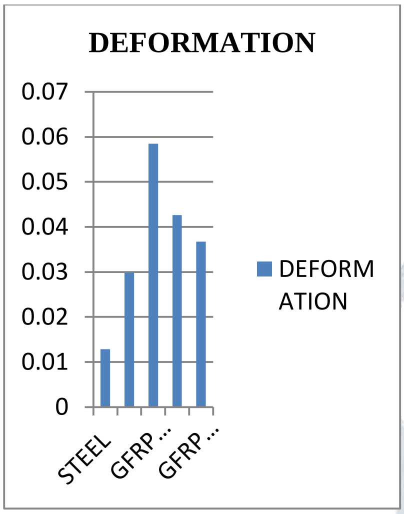


Figure20:

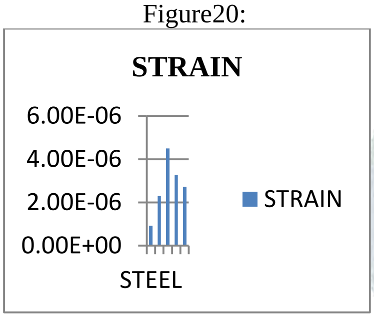


Figure 21:

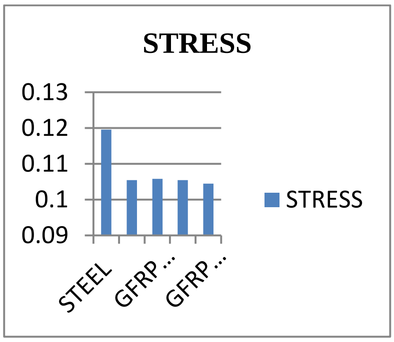


Figure 22:

CONCLUSION

The model and numerical investigation of electric two-wheeler frame with different materials and conclusion were made as follows: -Using the results which are illustrated in the numerical investigation, the overall design is safe, effective, lightweight and reliable for the needs.

Instead of the existing material like steel, the various materials can be used such as glass fibre epoxy composite and also reinforced with natural fibres. The GFRP materials was provided lesser deformation, therefore it withstands the load and as well it's may suitable for load carrying members.

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