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Development of Bike Frame Using Glass Fiber Reinforced Polymer Composites Prosopis Juliflora

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ABSTRACT: Composites have been found to be the most promising and reliable material on the market today. Composites reinforced with fibres of synthetic or natural materials are currently gaining relevance as the market needs for lightweight materials with high strength for specific applications. As a result of their high strength to weight ratio, fibre-reinforced polymer composites are not only extremely durable and resistant to corrosion; they are also highly resistant to flexural strength, dampening property, flexural fatigue and fire. Since composite materials may be used in so many different industrial fields, it's no surprise that they've found use in so many different types of products. Electric bikes that use electricity as their primary source of power because of their eco-friendliness and affordability, e-bikes are increasingly being used for transportation. Static and vibration analysis for commercial purposes were used to model and analyse an electric bike's optimal design in the current study. Bike frames serve as both a framework for the bike and its entire weight-bearing capacity. An electric bike frame with steel, composite reinforced with sugarcane and prosopis juliflora powders is the primary goal of this research project. As a result of the AISI standard, lightweight composites are just as robust, safe, and cost-effective than heavier, more traditional ones. In order to determine the effects of a sudden impact on any of the frame's components, static and vibration analysis was performed. We'll get to the conclusion that the e-bike design has been modelled and analysed using various materials and components. Results were compared to existing and proposed materials and the best material is selected and experimental investigation is carried out like laminate preparation and tested the mechanical behaviour of composite materials is investigated, the glass fibre reinforced with prosopis juliflora has better strength.

I. INTRODUCTION

The introduction of the E-Bike, or electrically assisted pedal cycle, is a significant modern event that could have a significant impact on existing mobility patterns. As the electric car market continues to evolve, in the industry itself. A good illustration of this is the electric bicycle, which is a type of electric vehicle (e-bike) [1]. Most e-bikes have a battery that can be recharged with a conventional household power outlet and a motor that is built into the bike's drivetrain. A computer screen and controller mounted on the handlebars allow the rider to fine-tune the output power and speed of the motor. It's a general term for a wide range of two-wheeled electric vehicles, some of which can be propelled by simply twisting a throttle [2]. Everybody is aware of how limited and depleted fossil resources are becoming. This has resulted in an increase in renewable energy sources, which do not deplete natural resources and do not contaminate the environment, becoming increasingly popular around the world.

As a major source of energy, electricity is rising at an astronomical rate. A new generation of electric vehicles is also finding its way to market, bringing with them improved range and performance that previously could only be found in cars powered by traditional gasoline engines. Fuel-efficient vehicle design is becoming more important as fossil fuel usage continues to climb. As a result, a small number of hybrid electrical applications are using new technologies. But they've been shown to be less expensive than the current choices [3].

1.1 Polymer Reinforced with Fibres (FRP)

High-performance fibre composites are achieved and made viable by cross-linking cellulosic fibre molecules with resin molecules in the material matrix using a patented molecular re-engineering process, creating a product with excellent

structural qualities. Using polymer matrices with fibre reinforcement to create tribologically significant composites is a successful strategy. Glass, carbon, or aramid fibres are the most common, but other fibres, such as paper or wood, or even asbestos, have been employed on rare occasions [4]. There are still phenol formaldehyde resins in use, as well as epoxy, vinyl ester, and polyester thermosetting plastics. FRPs are widely employed in the aerospace, automotive, marine, and construction sectors. In most cases, the goal is to create a component with a low density that is both robust and stiff. There are many commercial materials that include glass or carbon fibres in thermosetting polymer matrices. Composites made of FRP materials are strong, lightweight, non-corrosive, and easy to fabricate, all of which make them ideal for a wide range of applications.

1.2 Aims and Objective:

1. One of the project's objectives is to study the design and analysis of electric bike chassis.
2. Enhance performance by modelling and syncing the chassis.
3. To manufacture the chassis frames for electric bicycles.
4. To ensure the validity of experimental data in the context of displacement and stress analysis.

1.3 Methodology:

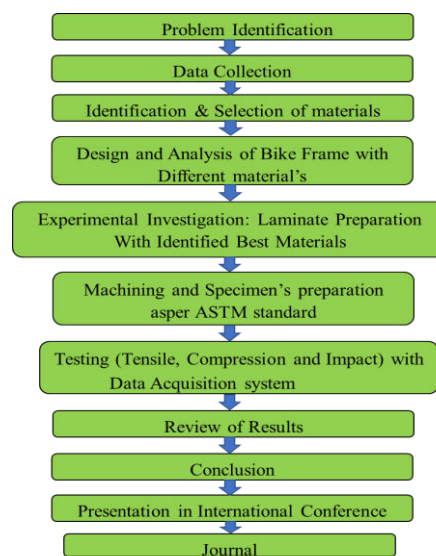


Figure 1 : Methodology

II. MATERIAL

2.1 Structural Steel

Steel structures can be constructed using a wide range of steel constructions, each with its own set of pros and cons. The maximum elastomeric modulus of steel is shown at the beginning of the curve. It's safe to say that when loads are applied to a structure that's in this range, steel doesn't bend permanently. Stable tension causes strain fluctuations in a steel structure, which is known as creep. Chronic stress and exposure to fire can cause it. Apart from situations when the influence of fire should be taken into account, structural steel frame creep is small when it comes to design and building.

2.2 GFRP

GFRP composites (glassfiber-reinforced polymeric) were the most frequently used in the fabrication of composite materials. The matrix was made from a variety of resins, including organic, polyester, thermoset, vinylester, phenolic, and epoxy. Bisphenolic polyester resins and ortho or isophthalic polyester resins are two subcategories of ortho or isophthalic polyester resins [5]. There are a number of factors that go into making a fiber-reinforced composite perform mechanically, including: fibre strength and modulus, chemi-stability, matrix strength, and interface bonding that permits stress transmission. GFRP composites were able to attain the desired properties and functionality by utilising the proper fibre compositions and orientations. In comparison to aluminium, the specific gravity of GFRP composites was one-quarter that of steel [6]. The mechanical and tribological properties of the composites in this work were improved using a range of glass fibre reinforcements, including long longitudinal woven mat, chopped fibre (distinct), and chopped mat.

2.3 Sugarcane fibre

The environmental friendliness and low weight of natural fibre reinforced polymer matrix composites have made them popular around the world in recent years. In sight of increasingly stringent environmental restrictions, scientists are being urged to produce environmentally friendly composites that may be used in both residential and commercial settings. The most sought-after materials of the twenty-first century include biodegradable and renewable composites derived from plant fibre and agricultural polymers. Environmentally friendly, sustainable, and green composite materials manufactured from plant-derived fibre and crop polymers are in great demand in the twenty-first century.

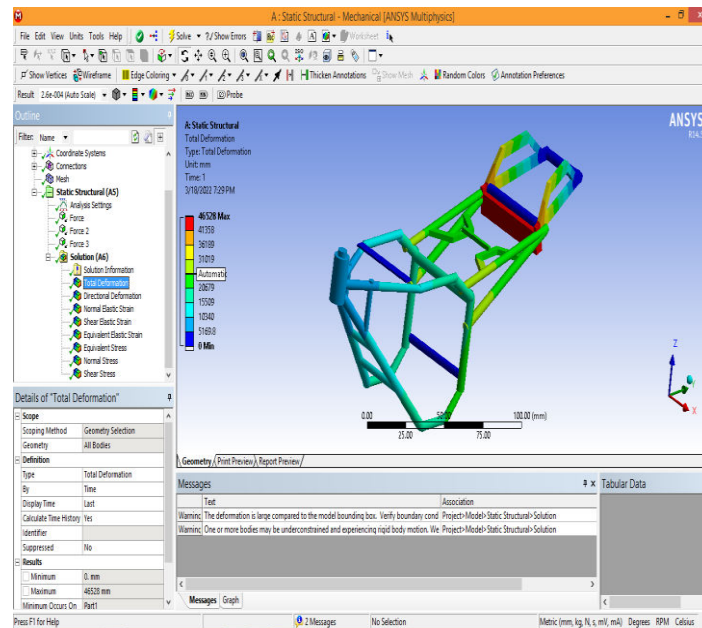
Chopped cane sugar fibres measured 7 to 11 centimetres in length. Before being employed in composites, natural fibres are treated chemically. For around 8 hours, fibres were soaked in water containing a 3 percent NaOH solution. After that, the fibres were dried for four hours in a 60-degree C oven. The fibres were allowed to dry for 24 hours at room temperature before being in use [7]. Application of a chemical treatment increased the fiber-matrix compatibility and adhesion.

2.4 Prosopis juliflora (PJ)

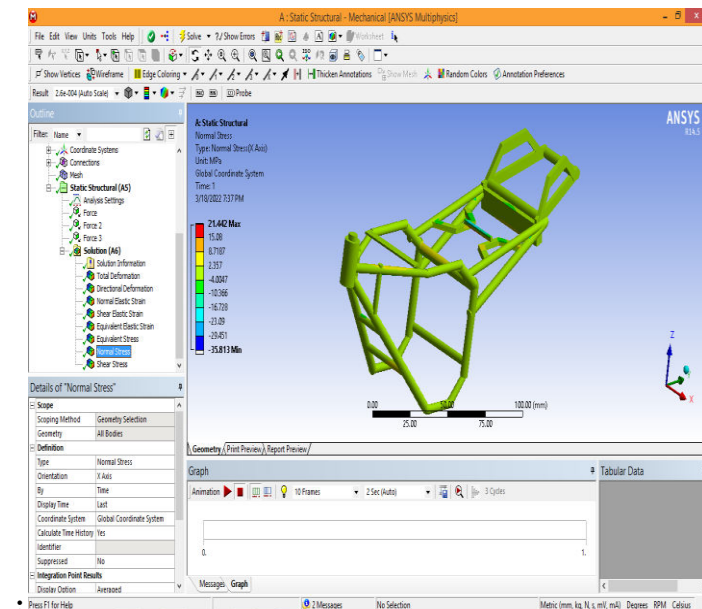
The blooming plant Prosopis juliflora, native to Mexico, South America, and the Caribbean, is a Prosopis species. One of the leguminosae family of plants that grows in Latin America, it can be found in Mexico and the Caribbean. They can grow to a height of 12 metres and a trunk diameter of 1.2 metres. They produce flowers after developing leaves, which are often shaped like a long green-yellow cylindrical spike arranged in a cluster. They have light green, deciduous leaves with 12 to 20 leaflets and generate blooms after the leaf development [8]. Unlike plants, they reproduce more quickly through seed transmission by cattle and other livestock than through vegetative means like as flowering and fruiting. In order to thrive and grow, these nitrogen-fixing plants must not rely on any external influences, such as the weather. Unchecked growth of Prosopis Juliflora is projected to lead to dense, impermeable bushes that will be classified as a hazardous weed, with significant economic and ecological effects for the surrounding community [9]. Water is poisoned and groundwater is drained as a result of its establishment, which causes groundwater depletion problems.

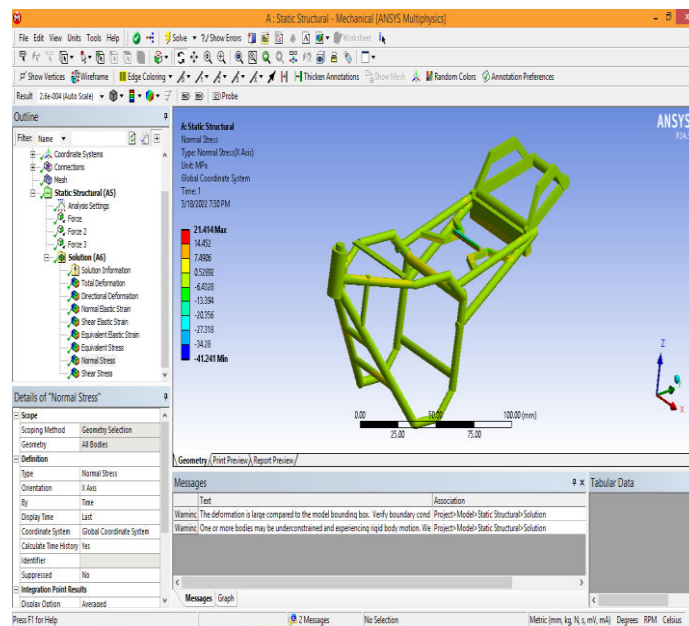
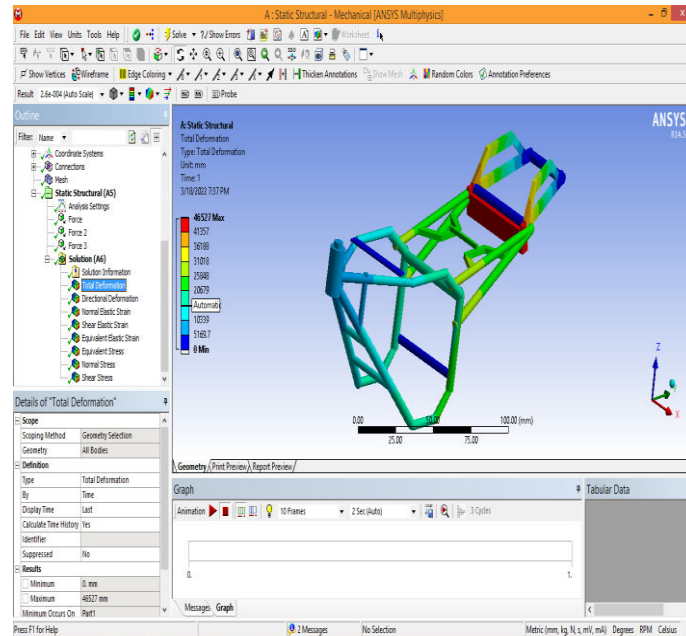
III. ANALYSIS AND RESULTS

3.1 Structural Steel:



3.2 GFRP





3.3 Sugarcane fibre:

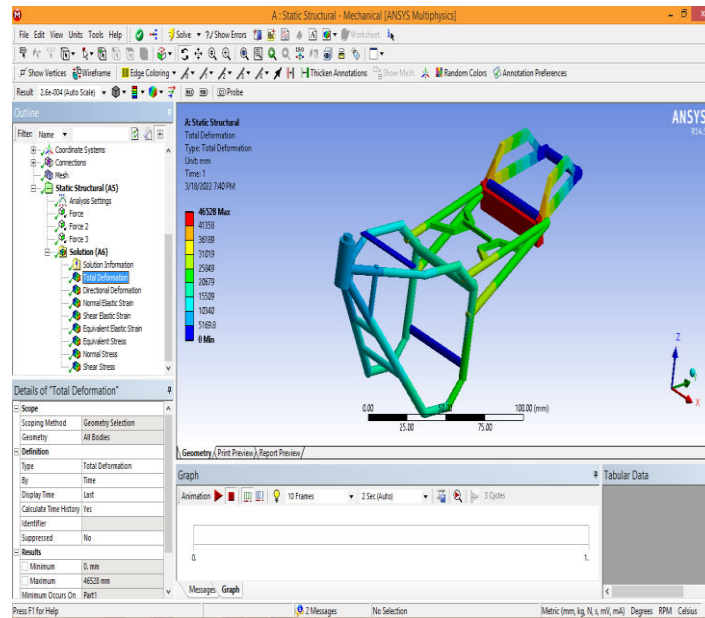


Figure 2.5: Total Deformation of GFRP with Sugarcane Fibre

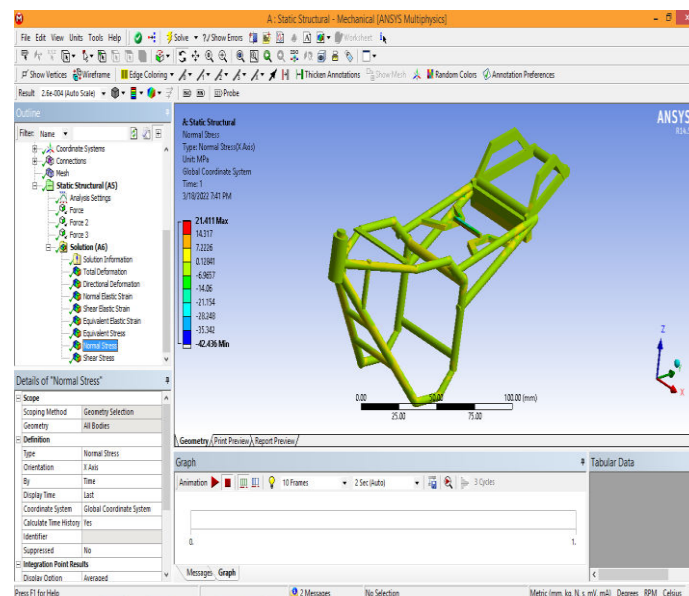
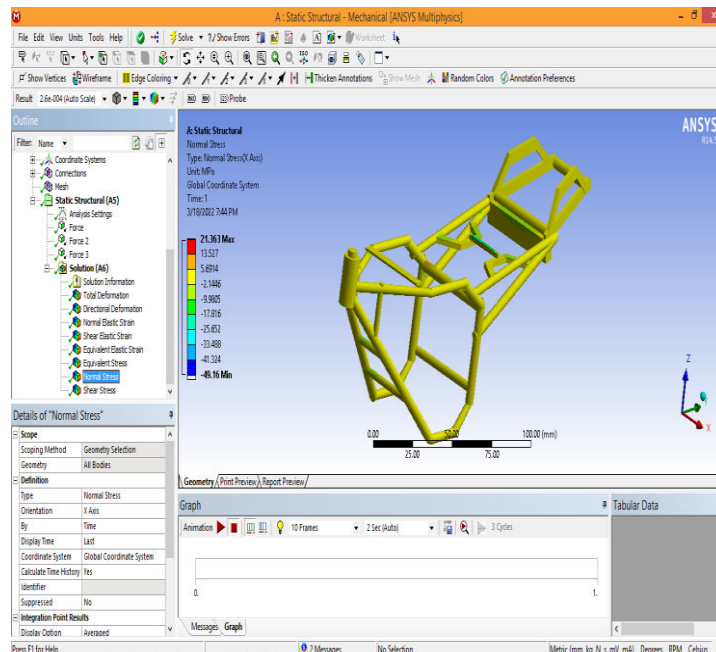
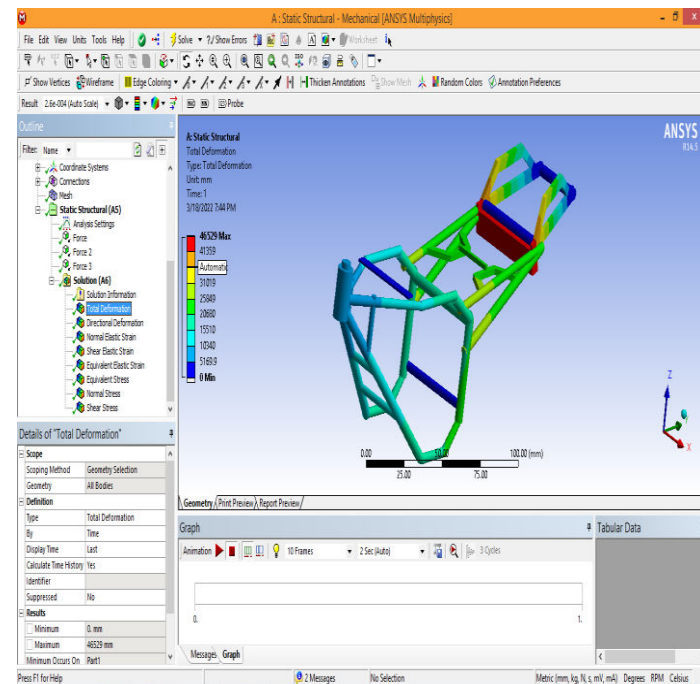


Table 3.1: Total Deformation

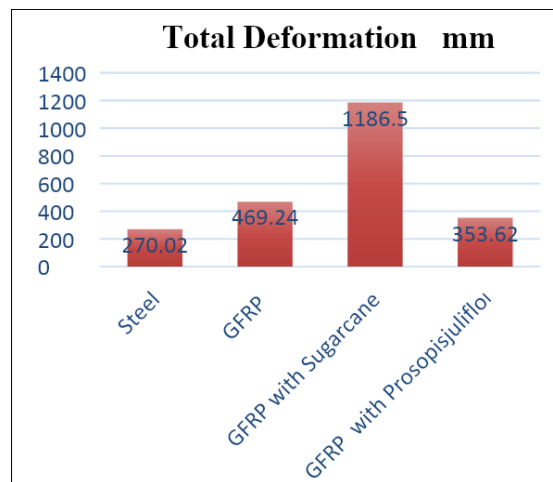
3.4 Prosopis juliflora (PJ):



3.5 Comparison of Vibration Analysis Result

3.5.1 Total Deformation

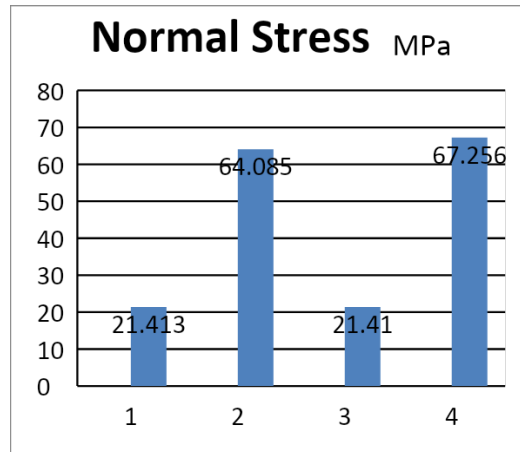
| TOTAL DEFORMATION (mm) | |
|------------------------------|--------|
| Steel | 270.02 |
| GFRP with Sugarcane | 1186.5 |
| GFRP with Prosopis juliflora | 353.62 |
| GFRP | 469.24 |



3.5.2 Normal stress

| NORMAL STRESS (Mpa) | |
|------------------------------|--------|
| Steel | 21.413 |
| GFRP with Sugarcane | 21.41 |
| GFRP with Prosopis juliflora | 67.256 |
| GFRP | 64.085 |

Table 3.2 : Normal Stress



IV. EXPERIMENTAL WORK

4.1 GLASS FIBER EPOXY LAMINATION WITH PROSOPIS JULIFLORA:

Follow the process below to make a GFRP with prosper juliflora:

Step 1: Take six pieces of grade 700GSM GFRP and trim them down to 300*330mm dimensions.

Step 2: 250ml LY556 epoxy resin is mixed with 25ml HY951 hardner.

Step 3: GFRP weight is measured. To the resin and hardener solution, add 10% prosper juliflora.

Step 4: Place a transparent sheet on a clean table and wax it for easier plate removal.

Step 5: Place the first layer of GFRP to the waxed sheet above it and coat it tightly with brush-mixed resin and hardner.

Step 6: Repeat steps 4 for the remaining five layers.

Step 7: Place transparent sheet above last layer and eliminate air bubbles with roller.

Step 8: Dry the plate for 24 hours while keeping weight above it.

Then sliced according to the size of ASTM standards for testing.



Figure 3.1: GFRP with Prosopis juliflora lamination

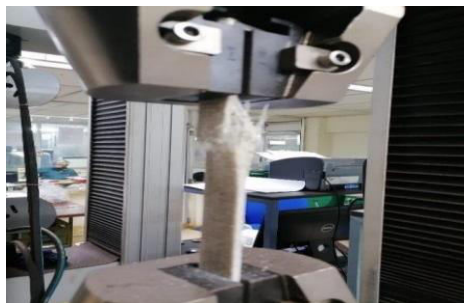
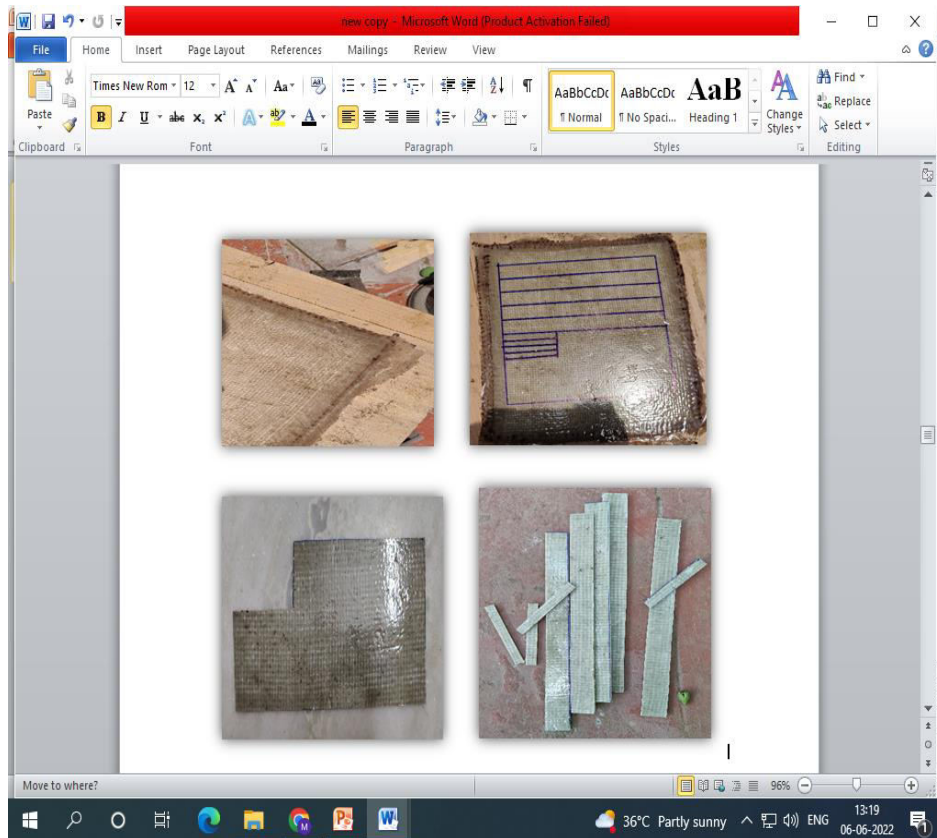


Figure 4.2: Machining process of GFRP with Prosopis juliflora

4.2 TESTING AND OBSERVATION

4.2.1 TENSILE TESTING:

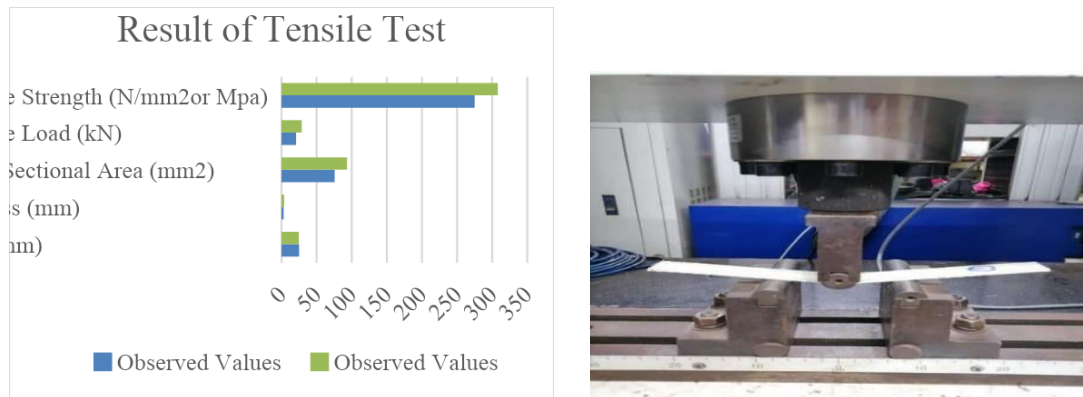
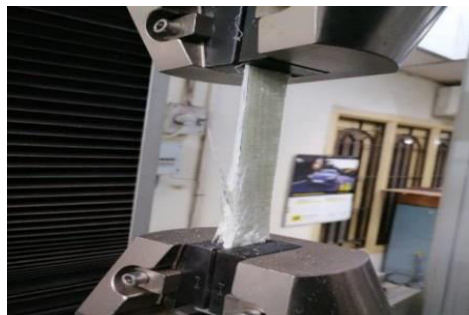


Figure 4.3: Result of Tensile Test



4.2.2 COMPRESSION TESTING:

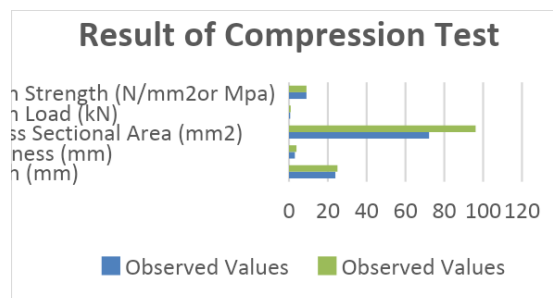
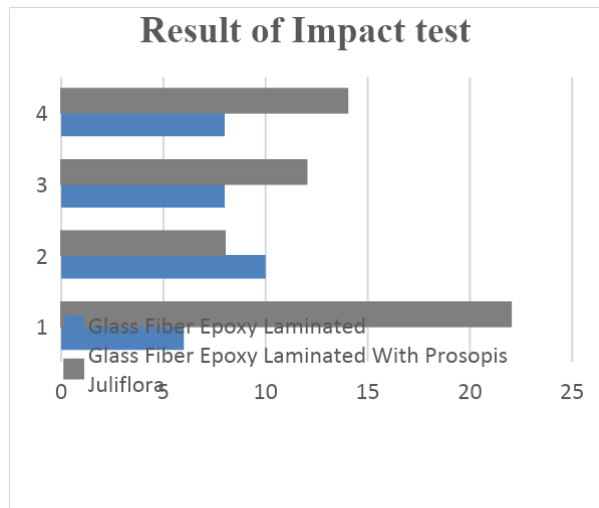


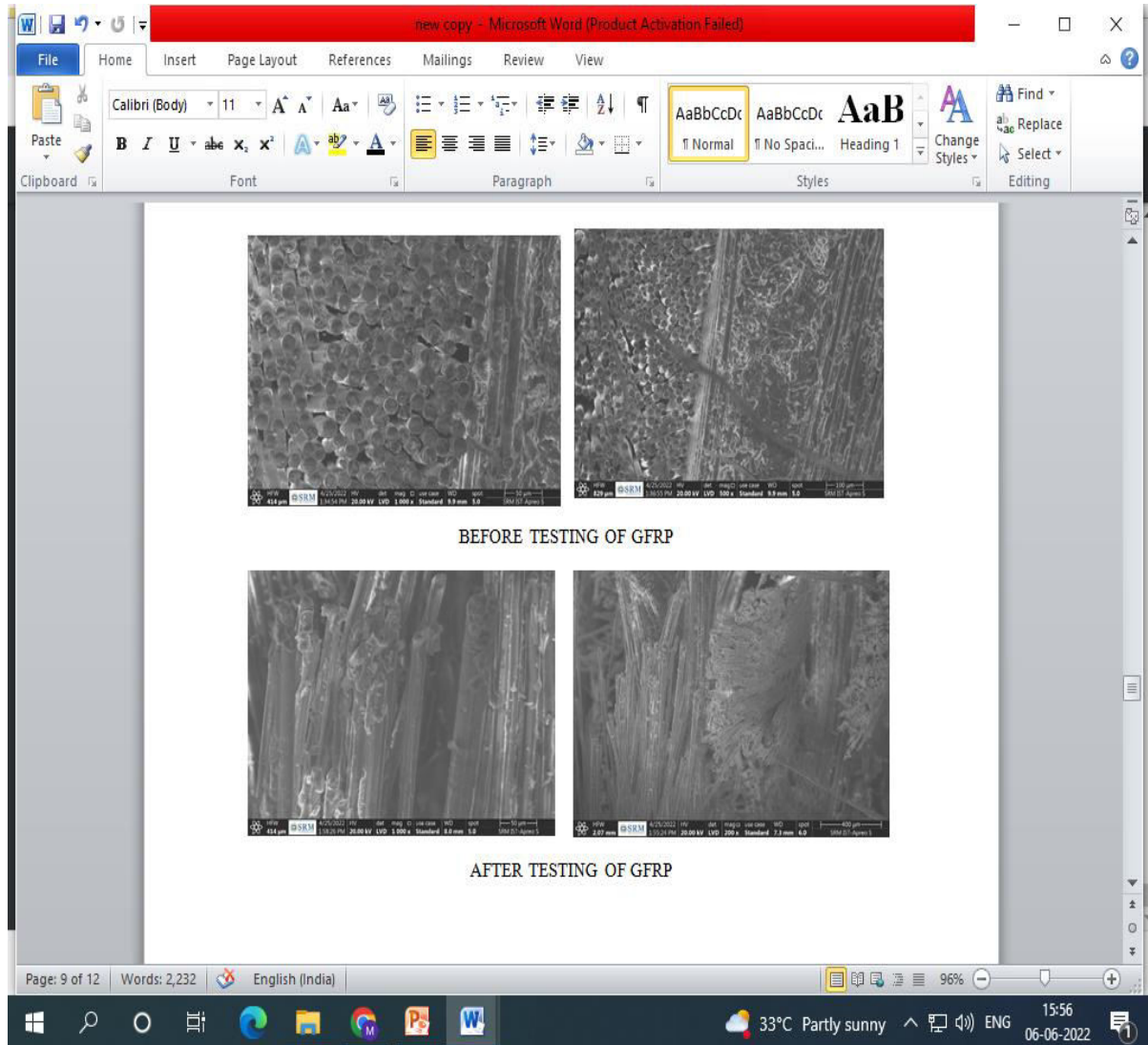
Figure 4.4: Result of Compression Test



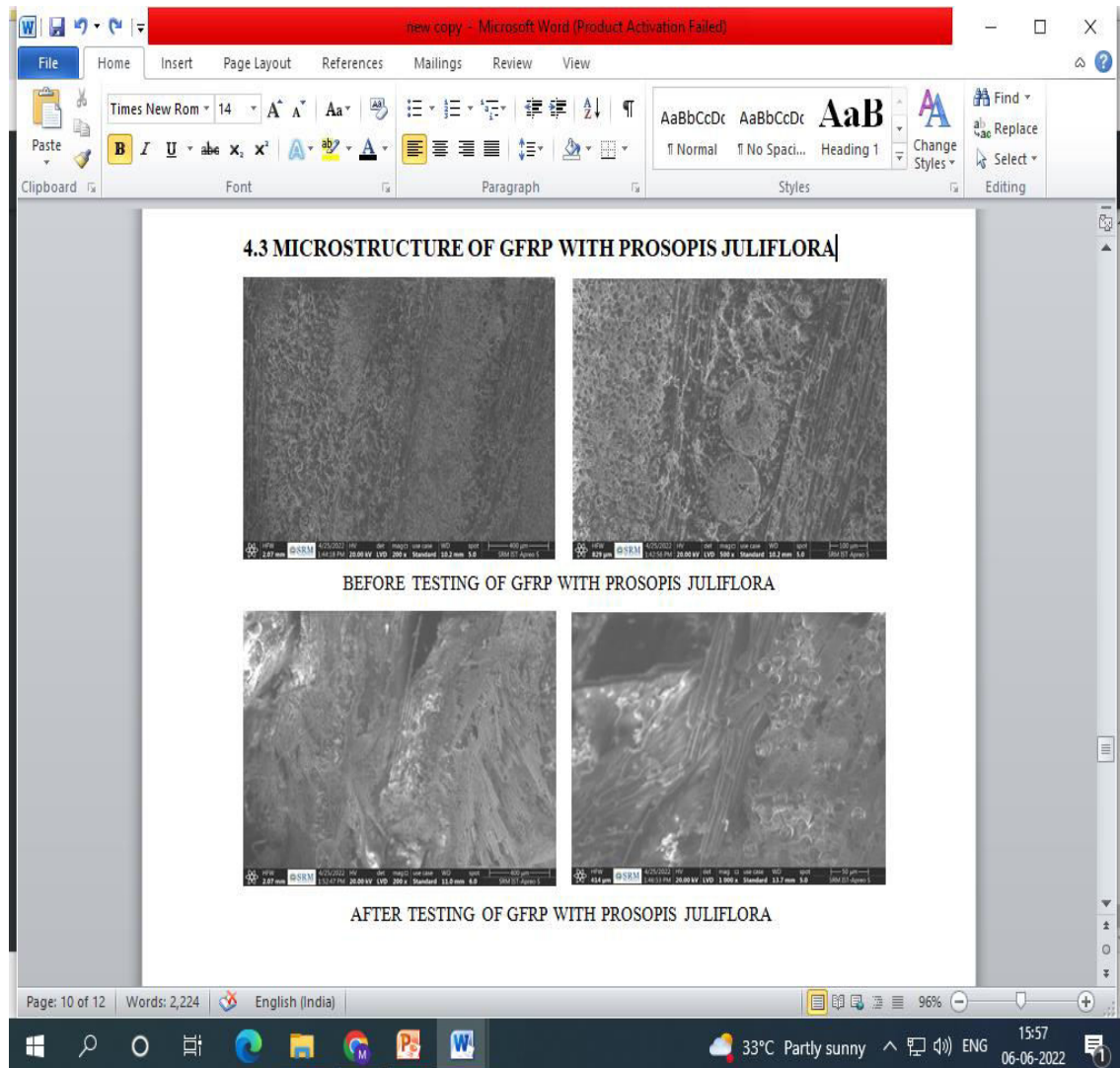
3. IMPACT TESTING:



4.3 MICROSTRUCTURE OF GFRP



4.4 MICROSTRUCTURE OF GFRP WITH PROSOPIS JULIFLORA



V. CONCLUSION

Catia software was used to model an electric two-wheeler frame design. In addition, the acquired numerical analysis findings led to the following conclusion: the overall design is safe, effective, light, and dependable for the needs. Various materials, such as glass fibre epoxy composite and reinforced with natural fibres, can replace the currently employed material, such as steel. Due to its lengthy deformation capability and dynamic nature, the GFRP reinforced with prosopis juliflora materials may be ideal for use in load-carrying components. The Glass fibre reinforced polymer with prosopis juliflora was also proven to be a desirable material for the construction of two-wheeler frame components.

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