Design and Analysis of Vehicle Front Bumper for Light Weight Vehicle Using Sugarcane Bagasse Fiber Reinforced Composite

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***Abstract*—Bumper is the one of part having more weight present cause. In this project is constructing less weight impact Saturation Suspension profile are Consumed. Natural Fiber Composite material is the great potential for engineering in many applications. The mechanical properties such as hardness, tensile Strength, tensile modulus, ductility, and peak load of the Natural Fiber composite were determined as per ASTM Standards. Bumper is the one of the parts having more weight present Cause. In this paper the existing Carbon Fiber light weight vehicle front bumper replaced with Sugarcane Bagasse Fiber Composite. this works the design and analysis of front bumper made of carbon fiber and sugarcane bagasse fiber with the help of ANSYS Software Version-Workbench 2022 R2.**

***Index Terms*—Front Bumper, Carbon Fiber, Sugarcane Bagasse Fiber,**

I. INTRODUCTION

The introduction of newer polymer resin matrix materials and high-performance reinforcement fiber of carbon fiber, the penetration of these advanced materials has witnessed a steady expansion in Uses and Volumes.[1] A good design of vehicle front bumper must provide safety for passengers and should have low weight Different countries have different performance standards for bumper.[2] Bagasse Fibers are the bast fiber like as natural fibers. It Consist of water fiber and small amount of soluble solid.[4] Composite are multifunctional materials systems that provide characteristics not obtainable from any discreate materials. They are cohesive structures made by physically combining two or more compatible materials, different in composition and characteristics and sometimes in form.[12] Bumpers play an important role in preventing the impact energy from being transferred to the automobiles and passengers. Saving the impact energy in the bumper to be released in the environment reduces the damage of the automobile and Passengers. The goal of this paper is to design a bumper with minimum weight by employing the sugarcane bagasse fiber material.[14] Front bumpers are important for cars because they play an important role in reducing the impact of energy during a collision. Bumpers are designed and fitted in a car to reduce and minimize impact to passengers. Bumper is usually made carbon fiber composites materials. In recent year, automobiles manufacturers have fully shifted to natural fiber bumpers. Natural fiber bumpers provide the less weight with higher stiffness.[26]

II. LITERATURE SURVEY

Researchers have begun to focus attention on a natural fiber composite (i.e. bagasse fiber) which are composed of natural or synthetic resin reinforced with natural fibers fiber exhibit many advantages properties they are a low-density material yielding relatively lightweight composites with high specific properties.
D.Verma and P.C Gope [2012] studied [01] the Fiber are strong and stiff relative to the matrix and are generally orthotropic. The abundant Availability of natural fiber in India such as Jute, Core, Sisal, Pineapple, Ramie, Bamboo, Banana etc. Thousands of tons of different crops are produced but most of their wastes do not have any useful utilization. These agricultural wastes include wheat husk, rice husk and

their straw, hemp fiber and shell of various dry fruits. These agricultural wastes can be used to prepare fiber reinforced polymer composites for commercial use. possible uses of bagasse water as reinforcement in polyester matrix composites and review regarding discusses the use of bagasse fiber its current status of research many referenced to the latest work on properties processing and application have been cited in this review.

G.A. Umadevi and N. Ramesh [2015] studied [02] Design and Analysis of an Automobile Bumper. The fuel efficiency and emission gas regulation of passenger cars are two important issues in these days. Bumper is the one of part having more weight present cause. In this paper the existing steel bumper is replaced with light weight with suspension bumper will attach in my project. A good design of car bumper must provide safety for passenger and should have low weight. Bumper plays an important role in preventing the impact energy from being transferred to the automobiles and passengers. In this project is constructing less weight impact saturation suspension profiles are consumed.

T.D Jagannath and G. Harish [2015] studied [03] Hybrid Composite material are the great potential for engineering material in many applications. The development of composite materials improves their performance based on the reinforcement of two or more fibers in a single polymeric matrix, which leads to the advanced material system called hybrid composites with a great diversity of material properties. The mechanical properties were determined as per ASTM standards. The mechanical properties were improved as the fibers reinforcement content increased in the matrix material.

Sachin Yadav and Gourav Gupta. [2015] studied [04] A review on composition and properties of bagasse fiber this review discusses about the use of bagasse fiber and its current status of research. Natural fibers have low cost, low density and low durability as compare to synthetic Fieber treatments mechanical properties improved. Bagasse fiber is a residue of a sugarcane milling a process the present use of bagasse fiber is a fuel in the sugar can Mill furnace. The wastage is used to prepare fiber reinforced form natural fiber polymer composites for many applications. The present review also focuses on the utilization.

A. Balaji and B. Karthikeyan [2015] studies [05] Bagasse fiber – the future bio composite material A Review this paper discusses about recent development of bagasse fiber reinforced polymer matrix composites in this study a series of epoxy-based composites reinforced with sugarcane bagasse waste fiber are fabricated up to landscape. This effort to develop bio composites material with improved performance for global application is an ongoing process. The reinforcing efficiency of natural fiber is related to the nature of cellulose and its crystalline. This review Paper Discuss About Recent Development of bagasse Fibers reinforced polymer composites, types of matrices, processing Methods, and any applications.

IfeOlorun Olofin and Ronggui Liu [2015] Studied [06] the Application of Fiber Reinforced Polymer (CFRP) Cables in Civil Engineering Structures. This review gathers the available literature on carbon fiber reinforced polymer (CFRP)cables. The behaviors of built in structures are very crucial especially structures with large dimension and long service, usually involving advanced technology. Hence, there is the need to understand the behavior of carbon fiber reinforced polymer (CFRP) cable which is considered to be a new discovery for making composite materials. A composite material is multi-phased and a combination of two or more individual materials that differ in composition. An example of such material is the CFRP, a very common composite stuff used in a multitude of applications ranging from its use in space related and aeronautic constructions to its use in space related and aeronautic construction to its use in building cars and ship.

Niketa Kankariya and Dr.F. B Sayyad studied [07] Numerical Simulation of bumper Impact Analysis and To Improve Design for Crash Worthiness. The major concern in design of bumper is their potentiality to bear impact loads. The crash performance of a bumper system is normally verified by results from standardized low speed crash tests based on common crash situations. Explicit finite elements method is used to investigate stress and effective plastic strain of bumper at impact. Car accidents are happening every day. Most drivers are convinced that Arey can avoid such troublesome situations. Permissible plastic strain safety zone as compared to other such as change of material or increase in thickness. Design modification is applied to the bumper to improve its impact performance

Pankaj Tripathi and Dheeraj Kumar [2016] Studied [08] Study on Mechanical Behavior of Sugarcane Bagasse Fiber Reinforced Polymer Matrix Composites.in this study a Series of Epoxy Based Composites Reinforced with sugarcane bagasse waste fiber fabricated. Natural fiber in composites clamed to offer environmental advantages such as increase dependance on non-renewable energy ratio of material sources, low pollutant emission, low greenhouse gas emission enhanced energy recovery and end of life biodegradability of components. Bagasse is main use as a burning raw material in the sugar cane mill furnaces. The low caloric power of bagasse makes a low efficiency process also sugar cane mill management encounters problem regarding regulations of clean air from the environment protection agency, due to the quality of the smoke released in the atmosphere. Bagasse is Considered to be a by- product of the milling processes after production of sugar. The low caloric power of bagasse makes a low Efficiency process also sugar cane mill management encounters problem regarding regulation of clean air from the environmental protection. Usually, this excess is deposited on empty fields altering the landscape.

Panimayam and Chinnadurai [2017] Studied [09] Carbon fibers were the most attractive fibers to researchers, engineers and scientists as an alternative reinforcement for fiber reinforced polymer (FRP) Composites. Advantage of FRP Over steel steps as external reinforcement is its easy handling. Carbon fiber has high tensile strength and modulus of elasticity and a brittle stress-strain characteristic. Wet layup method is most widely used for wrapping. The use of carbon fiber reinforced polymer (CFRP) Materials has increased significantly in the last decade. This paper is a review on the properties of carbon fiber reinforced polymer composites in the strengthening of reinforced concreate column.in this article let us study about the various properties of carbon fiber with the reference of various literature-based study.

S. Seenuvas and N. Nagendran [2017] Studied [10] The aim of this paper is to design a bumper with three different subsystems and to find the best among them using simulation form L-S Dyana. This bumper absorbs the impact energy and transfer to the opposite direction of the impact. Carbon fiber foam composite, Steel-Magna alloy and aluminum-honey comb materials are used for this analysis. Additionally, the better material was applied for two different bumper models and energy absorption, stress and total energy values are plotted and compared. From the LS-Dyna Simulation study, we could infer that the aluminum content in the automotive vehicle will nearly be implemented in the future for its low-cost effectiveness and carbon fiber composites has the ability to perform extremely well in the case of a crash. Hence, From the Above comparative study table result, which was obtained through LS-Dyana simulation.

Tofas Turk Otomobil Fabrikasi A.S R and D Center [2017] Studied [11] Finite Element Simulation of Dent Resistance for Automobile Rear Bumper. In automotive industry, there is an increasing demand for weight reduction. On the other hand, extraordinary style for automotive exteriors is used in order to increased. This study shows an objective measurement and consistent correlation level of static dent resistance for experiment or rear bumper that used an automotive with new design the Highter percentage of correlation leads virtual analysis team and design team to achieve the robust solution in early steps of design prosses. In this study, static dent resistance for automotive exterior rear bumper investigated by using nonlinear finite element method.in addition the results that are obtained from physical test are also presented here to compare with the results of finite element simulation to see percentage of correction.

Mahesh's. and T. Venkata Gowda [2018] Studied [12] Sugarcane bagasse reinforced polyester composites in this study the objectives of paper are to evaluate the mechanical properties and characterization of sugarcane bagasse reinforced polyester composite. Plastic and ceramic have been the dominant emerging materials. Modern composite materials constitute a significant proportion of the engineered materials market ranging from every day to sophisticated niche application. product More recently natural fibers have been employed in combination with plastics. Gives attention on the development natural fiber composites primarily to explore value-added applications. The objectives of papers are to evaluate the mechanical properties and characterization of sugarcane bagasse reinforced polyester composites. The objective of paper is to evaluate the mechanical properties and characteristic of sugarcane bagasse reinforced polyester composites.

Arsi Phaneendra SKM Simhadri and Raghavendra Kilari [2018] Studied [13] Design and Analysis of car bumper by varying Materials and Speeds.in this paper study Bumper play an important role in preventing the impact energy from being transferred to the automobiles and passengers. The main bumper beam is the main structure for absorbing the energy during collision therefore suitable impact strength is the main expectation for each such a structure. In this work a cost analysis can be done. more materials, composites and alloys can be used as raw material in the manufacturing of bumper in the near future. the materials used for these analysis is aluminum B390 alloy, Mild steels and Glass mat Thermoplastic (GMT) Materials. Static and impact analysis is to determine the deformation and stress of the car bumper. Modal Anlayasis is to determine the natural frequency and deformation for mode shapes.

Reddy Sreenivasulu and K. Kamal Charan [2019] Studied [14] Parametric Design and Analysis of Four Wheeled car bumper using Catia and Ansys. Bumper play a vital Function in preventing the effect strength from transferred to the car and passenger. Saving the effect energy in the Bumper to be launched within the surrounding and reduced the damage of the car and the passenger.in this analysis, a bumper used for low passenger vehicle is used, this bumper absorbs the impact energy with its deformation or transfers it perpendicular to the effect route at distinct speeds. The systematic design approach is able to guide the designer to achieve the set goals. The conceptual design is very important in design activities because it forms the background work of the design.

Y Sarath and T Muneiah [2019] Studied [15] Design and Analysis of Automotive Bumper Using Composite Using Composite Materials. The simulation of motor vehicle is done for low velocity impact test, on the other hand, it should absorb all the energy excluding the energy absorbed by body panel, bumper over reinforcement radiator support, Etcetera, according to united nations Economic Commissions for Europe regulation number. The bumper beam is the main structure for absorbing the anergy of collisions. Automotive bumper beam is one of the key systems in car. Bumper beam design to prevent or reduce physical damage to front or rear end of the motor vehicles in collisions condition they protect the hood. trunk, grill, fuel exhaust and cooling system as well as safety related equipment such as the parking light, head lamp and tail light etc. A good design of the car bumper must provide safety for passenger and should have low weight.

Deepa.G. Devadiga and K. Subrahmanya Bhat [2020] studied [16] Sugarcane bagasse fiber reinforced composite recent advances and application in this study provide an insight on current research trends on development and characterization of bagasse-based composites in the study. The use of agricultural crop residues for materials development and fabrications offers various advantages such as easy and safe disposal at the end of service life, lightweight alternative materials with desirable acoustic properties. This review provides an insight on current research trends on developments and characterization of bagasse-based. composites. Various chemical treatments methods and processing techniques used to improve the mechanical thermal, acoustic, and aging properties of sugarcane bagasse reinforced composites sizes are summarized in the review.

Bhaskar Dhiman and Vijay Guleria [2020] Studied [17] Application and Future Trends of carbon fiber reinforced polymer Composites a Review in this paper discuss about Among all composite materials, carbon fiber reinforced composite have proved to be a phenomenal success and also called superhero of the material world due to their impressive chemical electrical, mechanical, thermal properties and best strength to weight ratio. Carbon fiber consists of carbon atoms bonded together to form a long chain. Carbon Fiber composites are best suitable critical situations where strength, stiffness, lower weight outstanding fatigue characteristic stress rapture failure high temperature, good electrically conductive thermal conductivity low linear coefficient of thermal expansion, chemical inertness, and high damping etc. are important. This work presents a detailed review of application and future trends of CFRP composites in various fields.

Mohammad Khairul Huda Indah widia Stute [2021] studied [18] Natural fiber reinforced polymer in automotive application A systematic literature review focus on the automotive field ecosystem and biodiversity. This literature review focuses on the progress of the development of polymeric materials applied in the automotive field. Vehicle have become an important aspect of economic terms. Efforts to developed effective and innovative materials are increasing being developed by researchers, especially

in the development and utilization of NFRP in the automotive sector due to increased demand and increased ecological awareness. The great potential of using NFRP materials and recycled plastics in the automotives sector presents a future challenge, namely the increasing need for naturally the increasing need for natural fiber in the long term which will certainly have an impact on ecosystems and biodiversity.

Santhanam Sakthivel and Selvaraj Senthil [2021] studied [19] this research paper on thermal and sound insulation application. Natural fibers are commonly used in diverse application and one of the most important applications is sound absorption. Sound absorbing and insulating properties on natural fiber hybrid composites using sugarcane bagasse and Babbo charcoal this research paper reports on sugarcane bagasse fiber. The density increases the sound absorption coefficient increases. The natural composites noise control performance contributes to its wider adoption as sound absorbers. These composites materials have adequate moisture resistance at high humidity conditions without affecting the insulation and acoustic properties.

Sri. Sunil Raj and M Amrutha [2022] Studied [20] Design and Fea Analysis of Bumper Using Honeycomb Structure. In this thesis analysis, is to be done for the bumper used for ford endeavor according to regulations and also by increasing the speeds. An automobiles bumper is the front most or rear most part ostensibly designed to allow the car to sustain a structural without damage to the vehicles safety systems.in this paper an automotive bumper system to a frame thought is set up for small structural test. The bumper part of vehicle safety performance evaluation.in this thesis design of a bumper used for Ford Endeavor is modified with honeycomb structure and analysis for its strength.in this thesis analysis is to be done by replacing the bumper material with polypropylene honeycomb structure.

Harish and V. Anurag [2023] studied [21] Analysis of Front Bumper of A car the main purpose of bumper is to absorb shock in case of a collision. Automotive design with economy safety and aesthetics have been a great challenge to design engineers. Current automotive vehicle structures have one fundamentals handicap, a short crumple zone for crash energy absorption one of the options to reduce energy absorption one of the options to reduce energy consumption is weight reduction. Several materials Have been used to develop these shock- absorbing capabilities, such as steels, aluminum, glass mat thermoplastic and sheet molding compound. Crashworthiness is the ability of the bumper beam to prevent occupant injuries in the event of an accident and this is achieved by minimizing the impact force during the collision.

Mahadev madgule and Padmakar Deshmukh [2023] studied [22] Experiments investigation on mechanical properties of novel polymer composites with reinforcement of banana fiber and sugarcane bagasse powder. Composite materials are proven weight saving materials the significant difficultly is making them affordable. The mechanical properties results depict that the specimen prepared with chemically treated fiber gives more strength as compared to untreated fiber composites. The specimen prepared with chemically treated specimen has a higher percentage of water absorption than the untreated. This novel hybrid composites material can be used in automobile, aircraft, building, sports, and household applications.

Di Wu and Laiwang Jing [2024] Studied [23] A study on the mechanical properties of glass Fiber Reinforced Defective Gypsum Boards. The purpose of the study was to use glass fiber to improve the performance of defective gypsum boards.as a waste derivative glass fiber has drawn a lot of interest from the engineering community. Glass fibers mitigate stress concentration and fortify sample integrity. Their absences lead to brittleness and stress concentration between double pores. A low glass fiber content weakens bonding, causing slippage a higher content inhibits microcracking and the fibers act as stress transferring bridges, enhancing cyclic loading behavior. This study Provides a new idea for the application of glass fiber as a waste derivative in brittle materials, which is helpful for the sustainable development of the construction industry.

Dr. Narayanan N.I, Archana T A [2024] Studied [24] Glass Fiber Composite Material have become indispensable in various due to their exceptional mechanical properties and versatilities comprehensive review paper explores the advancement, properties fabrication techniques, and application of these materials. Glass fiber composites have advanced to the point where different kinds of glass fibers designed for particular uses Have been developed. The fact that glass fiber composites are so widely used in the

construction, automotive, marine, aerospace and sporting goods industries points out how important they are to contemporary engineering and manufacturing. This review serves as a valuable resource for researchers, engineers, and practitioners seeking a comprehensive understanding of glass fiber composite materials and their potential applications.

Isiaka Oluwole and Samuel Olumide Falana [2024] studied [25] Mechanical and wear properties of developed cellulosic fiber particles hybrid reinforced epoxy-based composites for automotive application. Studies are presently ongoing to advance the development of bio composite materials through the exploration of the potential use of reinforcement of natural origin in polymer matrixes. The sisal fiber was extracted employing soil retting method, subjected to surface treatment, and combined with paper partials. thus, epoxy-based composites reinforced with hybrid sisal fiber- paper particles are suitable for automobiles application in the fabrication of bumper and other epoxy-based body parts.

Sai Kiran Sidde and Wai Ming Cheung [2024] studies [26] Comparing non – biodegradable plastic with environmentally friendly natural fiber composite on car front bumpers Production of plastics is growing, and plastics are used in a variety of products. The use of a specific type of natural fiber composites (NFC) material for front-bumper in cars is considered in this investigation. The use of jute fiber is adopted for the design of a car front bumper and compared with the plastic bumper thought finite elements analysis. Comparing non-biodegradable plastic with environmentally Friendly natural Fiber composites on car front bumpers design. This research concludes that jute fiber can potentially replace plastic as a green composite material application to minimize environmental damages.

Shruti.B. Garud and Kailas More [2026] Studied [27] Review of Sugarcane bagasse Fiber Reinforced Composites Material with resent application in this Paper Discuss about A composites materials is made by combining two or more materials to give a unique Combination of properties one of which is made up Siff, long fibers in place in automobiles a bumper is the front most or rear part ostensibly designed to allow the car to sustain an impact without damage to the vehicles. The Study will focus on exiting design improvement will be tested using fem software for impact loads as per international standards. Natural fibers have low cost, low density and low durability as compare to synthesis. Fibers, but with the help of fibers treatment mechanical properties of improved many references properties, processing and application have been reference in this review.

III. MECHANICAL PROPERTIES OF MATERIAL CARBON FIBER AND BAGASSE FIBER

Property	Carbon Fiber
Density (kg/m^3)	1500
Young's Modulus (GPa)	70
Poisson Ratio	0.30
Tensile Strength (MPa)	121

Table No. 1

Property	Bagasse Fiber
Density (kg/m^3)	800
Young's Modulus (GPa)	17
Poisson Ratio	0.25
Tensile Strength (MPa)	86.89

Table No. 2

IV. DESIGN OF FRONT VEHICLE BUMPER

Component: Front Vehicle Bumper 2D Drawing Using AutoCAD Software.

Vehicle Model: Maruti Suzuki Swift.

Length: (L) =1702 mm

Width (w) = 530 mm

Bottom Width = (w) 573 mm

Height = 544 mm

Front Curvature Radius = R493

Thickness: 3 mm

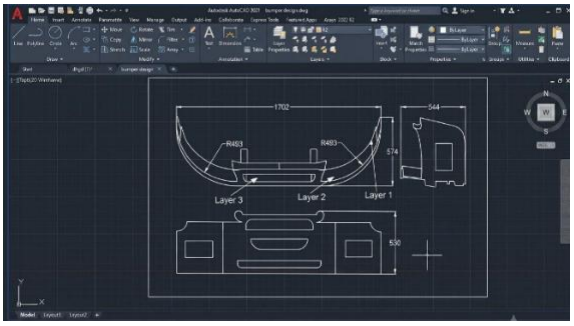

Fig. .1 2D Drawing of Maruti Suzuki Front Bumper using AutoCAD 2021

V. CALCULATION OF VOLUME AND AREA OF VEHICLE FRONT BUMPER

$A = L \times W$

$V = A \times t$

Overall, Bumper Assembly & Components Cutouts Dimensions (A_1 ,V_1)

$A_1 = 1702 \times 353.74 = 602.065 \times 10^3$ mm^2

$V_1 = 602.065 \times 10^3 \times 3 = 1.806 \times 10^3$ mm^3

Dimension Details of top center Cutouts (A_2 ,V_2)

$A_2 = 944.49 \times 69.12 = 59.663 \times 10^3$ mm^2

$V_2 = 59.663 \times 10^3 \times 3 = 178.990 \times 10^3$ mm^3

Dimension and Details of side Trim Part (A_3 ,V_3)

$A_3 = 453 \times 138.86 = 62.90 \times 10^3 \times 2$

$= 125.807 \times 10^3$ mm^2

$V_3 = 453 \times 138.86 \times 3 = 188.710 \times 10^3$ mm^3

$= 377.42 \times 10^3$ mm^3

Dimension and Details of Trim Part 2 (A_4 ,V_4)

$A_4 = 562.55 \times 86.46 = 48.638 \times 10^3$ mm^2

$V_4 = 48.638 \times 10^3 \times 3 = 145.914 \times 10^3$ mm^3

Dimension and Details of trim part 3 (A_5 ,V_5)

$A_5 = 480 \times 90.16 = 43.276 \times 10^3$ mm^2

$V_5 = 43.276 \times 10^3 \times 3 = 129.830 \times 10^3$ mm^3

Dimension and Details of trim part 3 (A_6 ,V_6)

$A_6 = 700 \times 60 =$ mm^2

$V_6 = 700 \times 60 \times 3 = 126 \times 10^3$

Area of Vehicle Front Bumper

$A = A_1 + A_2 – A_3 – A_4 – A_5 – A_6$

$= (602.065 \times 10^3) + (59.663 \times 10^3) – (125.807 \times 10^3) – (48.638 \times 10^3) – (43.276 \times 10^3) – (42.10^3)$

$= 10^3 (602.065 + 59.663 – 125.807 – 48.638 – 43.276 – 42)$

$= 402.007 \times 10^3$ mm^2

Volume of Vehicle Front Bumper

$V = 402.007 \times 10^3 \times 3 = 1.206 \times 10^6$ mm^3

VI. IMPACT FORCE CALCULATION OF BUMPER

Impact is usually a high force applied suddenly for a very short time when the car collides with another body. Impact force must be measured for the designed bumper because such force will have a greater effect than a lower force applied to a body over a longer period. The impact force on a car bumper is measured at different speeds to understand its stiffness and absorbing capacity.

Considering following data vehicle mass 1400 kg (passenger Vehicle)

Assume 1 person (Passenger) weight 75 kg

Considering 4 passenger and 1 driver total 5 person

Total weight passenger and driver

$= 5 \times 75$

$= 375$ kg

M1 passenger

single vehicle mass in kg

M2 Total Passenger weight in kg

Total Mass = m1 + m2

$= 1400 + 375$

$= 1775$ kg

Considering velocity of Vehicle 45 km/hr.

$= 45 \times 1000 \div 3600$

$= 12.5$ m/sec

To calculate kinetic energy for moving vehicle

$KE = 1/2 \times mv^2$

$= 1/2 \times 1775 \times 12.52$

$= 138.671 \times 103$ J

Kinetic Energy = Work done

138.671 w/kJ

Considering D is the Maximum displacement.

Substituting the values of m and V KE is equal to 138.671 KJ

The Displacement of car components will absorb the kinetic energy generated due to impact. Since it is a Frontal impact, the maximum displacement is constrained to 1000 mm, considering the safety of the passenger and major structural components of the car. This kinetic energy generated will represent the work done by the bumper during the collision in other Words work Done (w) = 138.671 kJ.

The Formula for work done is $W = F \times d$

W is the work done in kJ and d is the Maximum displacement of the bumper. The Unit of Displacement (d) in meter, and F is the impact force having is measured is in kilo Newton (kN). By Substituting the values for work done and Displacement, the force of impact is equal to F= w/d = 138.671/1 = 138.671 kN, Hence the impact force on the bumper = 138.671 kN. Therefore, theoretically at an assumed car velocity at 45 km/hr. (12.5 m/s), the impact force at different speeds. To study the impact analysis, the FEA method is Deployed.

Strain Calculation

$\varepsilon = 1.25/100$

$\varepsilon = 0.125$

VII. MODELING ANALYSIS OF CARBON FIBER (OLD MATERIAL)

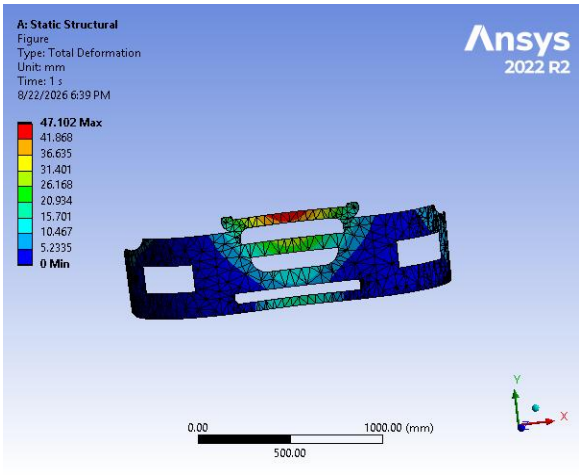

Fig.1 Total Deformation

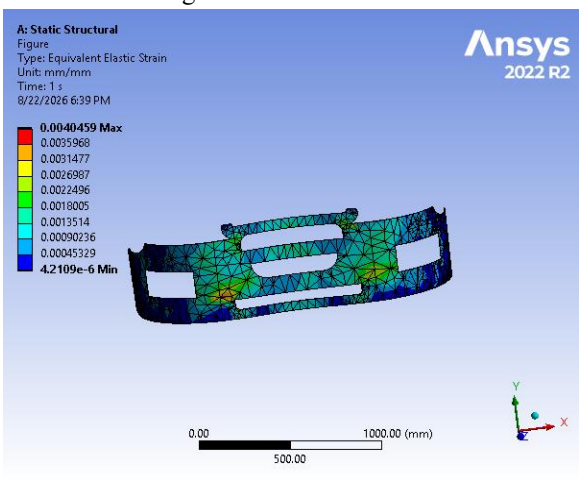

Fig.2 Equivalent Elastic Strain

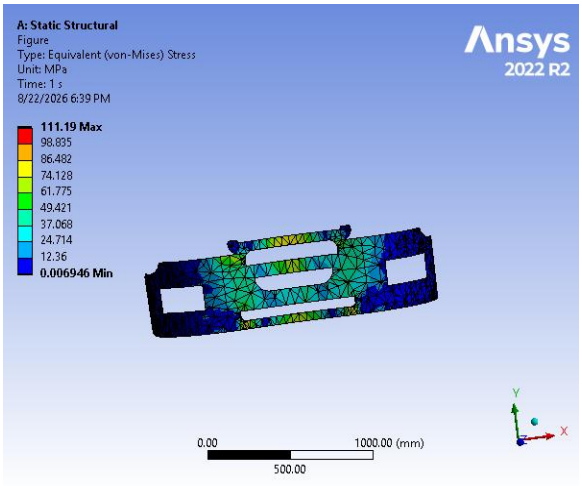

Fig.3 Equivalent Elastic Stress

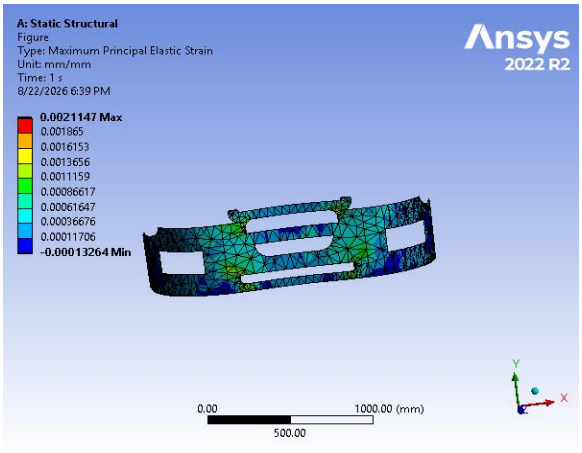

Fig.4 Maximum Principal Elastic Strain

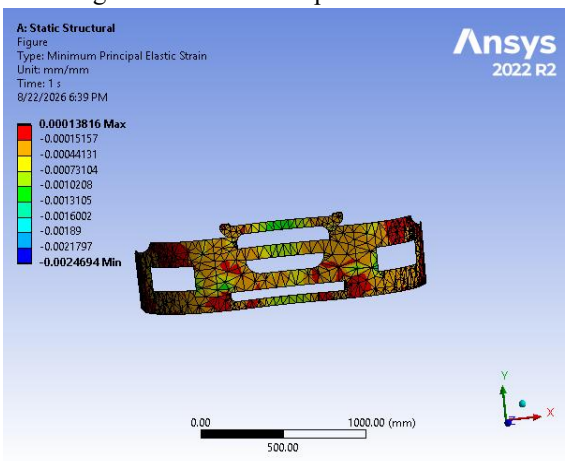

Fig.5 Minimum Principal Elastic Strain

VIII. MODELING ANALYSIS OF BAGASSE FIBER (NEW MATERIAL)

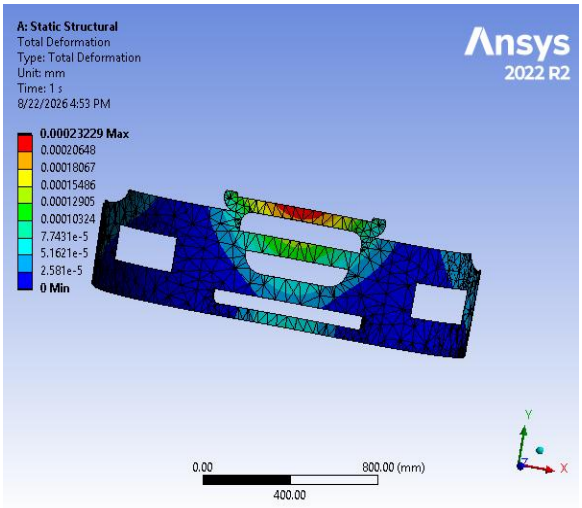

Fig.6 Total Deformation

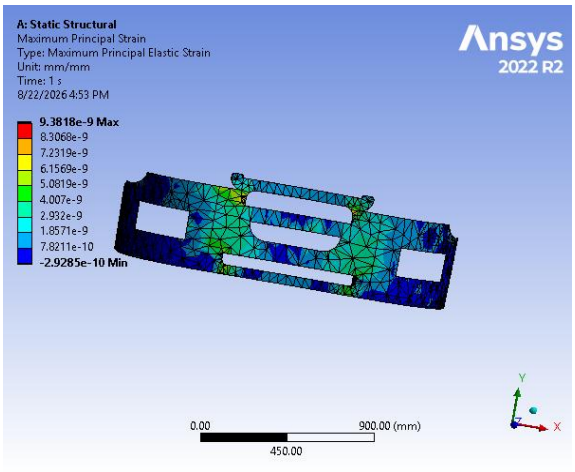

Fig.7 Equivalent Elastic Strain

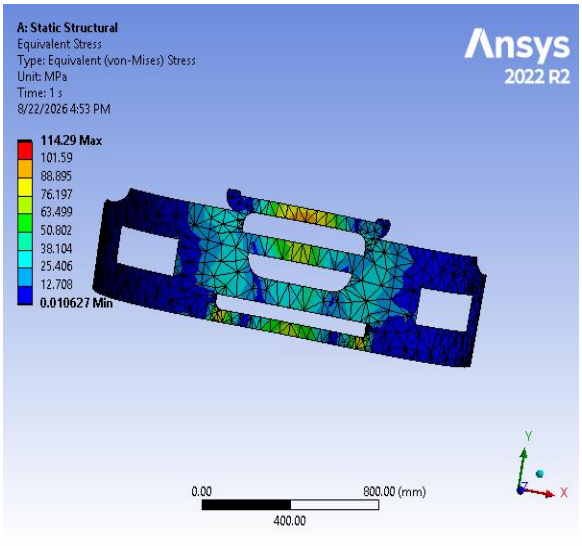

Fig.8 Equivalent Elastic Stress

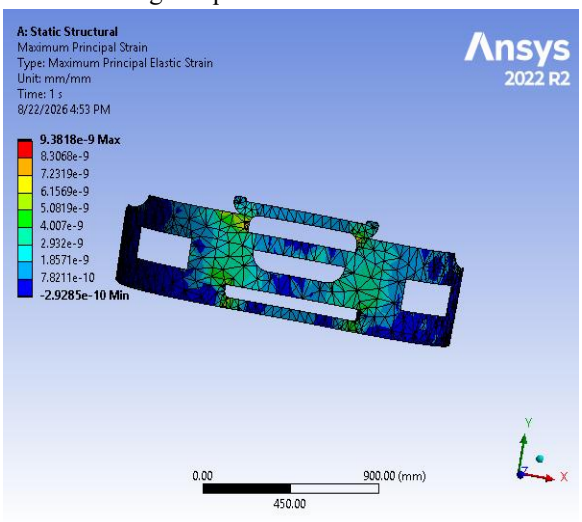

Fig.9 Maximum Principal Elastic Strain

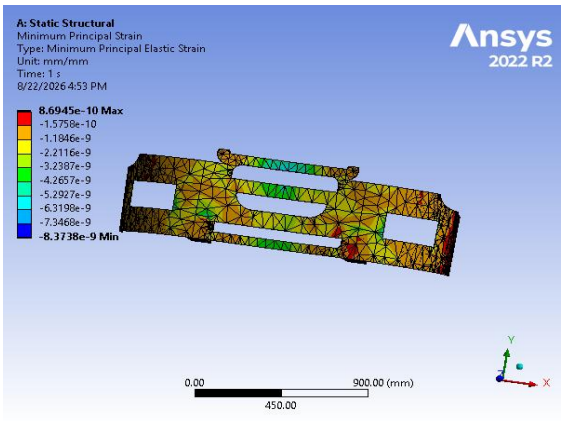

Fig.10 Minimum Principal Elastic Strain

IX. RESULT ANLYSIS OF (OLD MATERIAL) CARBON FIBER

Sr. No	Type	Minimum	Maximum
1	Total Deformation	0.00 mm	4.6655 mm
2	Equivalent Stress	6.881e-004 MPa	111.013 MPa
3	Equivalent Elastic Strain	4.170e-007 mm	4.0075e-004 mm
4	Maximum Principal Stress	-0.53704 MPa	10.557 MPa
5	Minimum Principal Stress	-10.988 MPa	0.3062 MPa

Table No 3

X. RESULT ANLYSIS OF (NEW MATERIAL) SUGARCANE BAGASSE FIBER

Sr. No	Type	Minimum	Maximum
1	Total Deformation	0. mm	2.3009e-005 mm
2	Equivalent Stress	1.0526e-003 MPa	11.321 MPa
3	Equivalent Elastic Strain	2.0041e-012 mm	1.7121e-009 mm

4	Maximum Principal Stress	-1.2174 MPa	10.757 MPa
5	Minimum Principal Stress	-11.543 MPa	0.85376 MPa

Table No 4

XI. COMPARATIVE ANALYSIS OF CARBON

$$\% \text{ Change} = \frac{\text{Bagasse Fiber} - \text{Carbon Fiber}}{\textit{Carbon Fiber}} \times 100$$

1) Total Deformation
$= \frac{2.3009 \times 10^{-5} - 4.6655}{4.6655} \times 100$
= -99.99 % (Decrease)
2) Equivalent Stress
$= \frac{11.321 - 111.013}{111.013} \times 100$
= -89.80 % (Decrease)
3) Equivalent Elastic Strain
$\frac{1.7121 \times 10^{-9} - 4.0075 \times 10^{-4}}{4.0075 \times 10^{-4}} \times 100$
= -99.99 % (Decrease)
4) Maximum Principal Stress
$= \frac{10.757 - 10.557}{10.557} \times 100$
= 1.89 % (Increase)
5) Minimum Principal Stress
$= \frac{0.85376 - 0.3062}{0.3062} \times 100$
= 178.82 % (Increase)

XII. COMPARISON OF CARBON FIBER & SUGARCANE BAGASSE FIBER

parameter	Carbon Fiber	Bagasse Fiber	percentage	Result
Total Deformation	4.6655 mm	2.3009×10^{-5}	-99.99 %	Decrease
Equivalent Stress	111.013 MPa	11.321 MPa	-89.80 %	Decrease
Equivalent Elastic Strain	4.0075×10^{-4}	1.721×10^{-9}	-99.99 %	Decrease
Maximum Principal Stress	10.557	10.757	1.89 %	Increase
Minimum Principal Stress	0.3062 MPa	0.85376 MPa	178.82 %	Increase

Table No 5

XIII. STIFFNESS CALCULATION OF OLD MATERIAL CARBON FIBER

Force = 138.671 KN
Carbon Fiber Deformation = 4.6655 mm
Stiffness = $\frac{Force}{Deformation}$
$= \frac{138.671}{4.6655}$ = 29.72 KN/MM

XIV. STIFFNESS ANALYSIS OF NEW MATERIAL BEGASSE FIBER

Force = 138.671 KN
Bagasse Fiber Deformation = 2.3009×10^{-5} mm
Stiffness = $\frac{Force}{Deformation}$
$= \frac{138.671}{2.3009 \times 10^{-5}}$
$= 6.0268 \times 10^{6}$ KN/MM

Material	Force	Maximum Deformation	Stiffness
Carbon Fiber	138.671 KN	4.6655 mm	29.72 KN/mm
Bagasse Fiber	138.671 KN	2.3009×10^{-5} MM	6.0268×10^{6} KN/mm

Table No 6

XV. CONCLUSION

Structural Suitability: Numerical and FEA results confirm that sugarcane Bagasse Fiber Composite offers strong structural response with reduced stress and deformation.

Eco Friendly alternative: Utilizes agricultural waste to provide a lightweight, renewable, and cost-effective material.

Sugarcane Bagasse Fiber composite serves as a viable, sustainable replacement for traditional Carbon Fiber in automotive bumper applications.

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