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Comparative Analysis of Carbon Fibre and E-glass Fibre Characteristics

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Abstract

In the contemporary automotive industry, the imperative focus on energy efficiency has driven the central role of lightweight, addressing challenges such as emissions reduction and fuel efficiency. Extensive research is underway to develop lightweight materials enhance recyclability, integration feasibility, and overall fuel efficiency These experiments were conducted in agreement with ASTM D638, ASTM D790-03, and ASTM D790 standards to ensure adherence to industry standards and facilitate meaningful comparisons. For the tensile test, specimens of both materials, carefully prepared to standardized dimensions. The specimens were subjected to increasing loads until failure. The maximum load (W) applied was meticulously recorded, enabling the calculation of the ultimate tensile strength (σ) resulting in a value of 389.26 N/mm² for both carbon fibre and E-glass fibre. Impact testing, conducted following ASTM D790-03 Standard, involved precise measurement of the initial energy on the scale (300 J) and the residual energy post-testing (28 J). The absorbed energy, a critical indicator of material resilience, was calculated as 272 J for both materials. The *results of the tensile and impact tests underscore the comparable mechanical performance of carbon fibre and E-glass fibre, highlighting their resilience and suitability for diverse engineering applications. These findings contribute to a better understanding of the mechanical properties of these materials, facilitating informed material selection and design decisions in engineering practice.*

Keywords: Lightweighting, carbon fibre, E-glass fibre, ultimate tensile strength, material resilience, Energy efficiency, mechanical properties, engineering applications.

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INTRODUCTION

The field of materials science has been significantly influenced by the advent of carbon fibres, playing a pivotal role in advancing industries ranging from aviation and military to automotive and medical applications. Carbon fibres are characterized by their remarkable properties, such as exceptional flexibility, low densities, and high resistance to thermal and chemical conditions. This article delves into the multifaceted realm of carbon fibres, exploring their composition, manufacturing processes, and wide-ranging applications. The discussion encompasses the growing demand for carbon fibres in diverse sectors, including the automotive industry, where they contribute to reduced weight and enhanced styling. The challenges and opportunities facing the carbon fibre industry, such as high production costs and the need for faster composite manufacturing methods, are also explored. From the global utilization of carbon fibres to key producers worldwide, this introduction sets the stage for an in-depth exploration of the dynamic and evolving landscape of carbon fibre technology.

Sundeep M et al. [1], Researchers globally are exploring Materials made by combining plastic with strong fibres to create additional cost-effective and environmentally conscious changes to copied fibre-reinforced composites. Recent material research advancements have led to hybrid materials like composites, aiming for high strength, low weight, and affordability. The focus is on developing structural materials that strike finding equilibrium among power and mass, with composites being a favourable choice. This project involved creating specimens with resin, pineapple leaf fibre, E-glass fibre and carbonate to evaluate composite effects. Mechanical characteristics, particularly ductile and flexural asset, remained assessed using a Materials testing machine in this Hand Lay-Up process-based project**.**

Khan T et al. [2], is a study focused on manufacturing hybrid laminates with low-viscosity Elium® resin, incorporating two types of glass and carbon fibres. X-ray computed tomography study exposed a weaker boundary between Elium® resin and glass fabric, resulting in higher void content in glass fibre specimens than carbon fibre specimens. Hybrid laminates with added glass fabric layers exhibited increased void content, negatively impacting overall mechanical performance. The hybrid specimen with a G2C4G2 stacking sequence demonstrated significantly enhanced flexural and tensile strength, attributed to the developed difficulty of carbon fibres and then improved fibre-matrix interface. Scanning electron microscopy highlighted distinct failure modes, with carbon fibre specimens showing fibre break and stiff letdown, while glass fibre samples exhibited fibre pullout, interfacial failure, and ductile failure.

Natarajan E et al. [3], check if a special type of glass and carbon fibres mixed with plastic can be used to make a strong material for submarine hulls when they're underwater. Polymer composites are explored due to concerns about metallic materials' decomposition in saline environments. Experimental analysis demonstrates advanced definite asset and toughness in the compound related to various metallic materials used for submarine hulls. Finite Element Analysis is working for the Analysis of static also dynamic crashes, optimizing the shape and thickness of each part, and nonlinear crash analysis reveals favourable crash safety factors at specific travel depths, particularly at 1750 m.

Zhang T et al. [4], examine a novel steel fibre-reinforced-carbon/glass mixture compound blocks through uniaxial tensile experiments, assessing variables like carbon/glass ratio and steel fibre arrangement. The research introduces a method for steel fibre tensile testing and identifies two damage modes based on carbon fibre fracture patterns. Results reveal effective control over tensile properties, and a comprehensive model is planned to see the delivery design of carbon and steel fibres.

Jiang H et al. [5], explore the mutual impacts and interactive effects disappointment instruments of a hybrid combination of carbon, glass, and Kevlar fibre-reinforced polymer composites for aeronautical applications. Different double-/multi-fibre HFRP configurations are proposed, and flexural tests demonstrate enhanced energy absorption (EA), with up to 152.9% then 76.2% developed EA than CF9 also KF9, respectively. Various hybrid effects are observed, and microscopic characterization reveals composite disappointment machines, involving both brittle and ductile breakage, buckling, fibre-splitting, and crack suppression. Validated finite element simulations further contribute toward understanding the mechanical behaviours, offering guidance for customized composite design.

Sivakandhan C et al. [6], a new study aims to assess the physical characteristics of point gourd natural fibre polymer coats, utilizing various mixtures of fibre to epoxy/polyester gum matrices. Results indicate enhanced tensile strength (140.68 MPa) and hardness (77.3) in ceramic fibre-epoxy resin laminates, highlighting improved mechanical characteristics. Additionally, compressive strength is notably increased in laminates incorporating ridge gourd fibres, showcasing its potential as a cost-effective and eco-friendly reinforcement.

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Shonar M et al. [7], experimental study investigates Carbon nanotubes mixed into a plastic layer within composite materials made of layers of carbon and glass, tested for how they respond to slow shear forces and cracking forces. Loading. Different laminate orientations are fabricated using a vacuum infusion process, and piezo-resistance measurements are obtained using circumferential probes. The study reveals varying interlaminar shear strength and fracture initiation toughness among different orientations, with the orientation showing the best resolution in crop harm detection and the greatest sensitive electrical response in mode-I fracture experiments.

Shaikh AA et al. [8], the paper employs finite element methods to numerically analyse the effects of Putting a steady force on epoxy composites strengthened with basalt, E-glass, S2 fibreglass, and carbon fibres, serving as economical another on the way to pure carbon fibre epoxy composites. Stationary tests are shown on composite specimens by changing loading orders, and failure analysis is performed using Tsai-Wu failure criteria. The study reveals that the best arrangement of layers basalt-carbon hybrids excelling Testing showed that materials combining glass and carbon fibres are stronger when stretched and bent. Also, layers with carbon fibre on the outside perform better in compression and shear exhibit better presentation.

Sivakandhan C et al. [9], study focuses on fabricating hybrid composites using sisal and jute fibres combined with epoxy resin and hardener as the matrix. Results reveal a significant 32% increase in Strength under pulling forces along the same axis for jute fibre/resin compared to Agave sisalana fibre/resin composites. Jute fibre/epoxy composites exhibit superior Pulling strength, bending strength, squashing strength, and collision resistance compared to sisalana hemp fibre/epoxy composites on similar fibre loading, supported by analysis.

Sunil B et al. [10], Natural fibre composites, similarly known as green composites, are ahead of attention as sustainable alternatives to synthetic reinforcements in various applications. Areca sheath-reinforced composites exhibit favourable mechanical properties, biodegradability, cost-effectiveness, and eco-friendliness, making them suitable for applications like packing material and general use. Alkali-treated areca sheath fibres show promise for manufacturing durable and environmentally friendly composites, offering potential replacements or combinations with glass fibres based on specific application requirements.

Fathima S et al. [11], Fibre-reinforced materials, dating back to the Stone Age, have played a crucial role in manufacturing. Carbon fibres, with remarkable strength and stiffness, are five times stronger and twice as stiff as steel, making them ideal for high-end applications. Glass fibres, while less stiff, offer high specific strength and cost-effectiveness, making them promising for widespread use. This provides an overview of the evolution, synthesis, mechanical properties, also potential applications of carbon fibre and crystal fibre-strengthened elastomeric composites, utilizing elastomeric polymers as matrices for their viscoelastic properties and flexibility.

Liu J et al. [12], compares the mechanical assets of basalt fibres and E-glass fibres in fibre-reinforced polymer (FRP) composites. Tensile strength, elastic modulus, and hardness are analyzed using a fibre tensile tester and nanoindentation. Results indicate that basalt fibres exhibit superior mechanical properties compared to E-glass fibres. The density of basalt fibres increases with higher iron content and X-ray diffraction shapes tell the shapeless nature of both fibre types, through iron oxide contributing significantly to the improved mechanical properties of basalt fibre.

Chandramohan D et al. [13], work reviews the tribological presentation of ordinary fibre-reinforced polymer composites, addressing key aspects of natural fibres, polymers, composites, and their applications in industries like automotive and construction. Emphasizing the need for Strong and wear-resistant characteristic, this work explores the potential of organic fibres as eco-friendly alternatives, driven by environmental considerations in composite material usage.

Rajak DK et al. [14], review paper provides a comprehensive analysis of glass and carbon fibres, the Significance of their characteristics, and classification. It extensively covers manufacturing techniques of Crystal Fibre Reinforced Polymer and Carbon Fibre-Reinforced Polymer composites, discussing advantages, limitations, then future trends. The paper also summarizes the physical, oscillatory, ecological, frictional, and heat-related aspects properties of both composites, offering valuable insights for understanding their behavior and predicting future research directions and applications.

Manjunath A et al. [15], focus on fabricating and characterizing Strong glass fibres mixed with Polyphenylene Sulphide, created by squeezing them together molding. Mechanical and thermal properties, including tensile, flexural, impact, and heat distortion, were investigated for varying glass fibre percentage by weight (10%, 20%, 30%, and 40% weight percent) results indicate the PPS Composite containing 30% weight percent of glass fibre. exhibited optimal mechanical then dielectric properties, with significantly improved Heat Distortion Temperature (HDT) attributed to Glass fibres making something stronger.

Prasad M et al. [16], explore Material with E-glass and carbon fibres strengthened by epoxy in a 5052 polymer base composites manufactured using the vacuum bag molding technique with thickness variations (2 mm, 3 mm, and 4 mm). Low-speed collision tests were carried out at various impact velocities energies, revealing a decrease in interaction period and an increase in topmost force by greater composite thickness. Ultrasonic scanning was employed to assess delamination in the damaged areas, providing insights into the material's response to impact.

Aydin MR et al. [17], investigate the dynamic performance of Composites without blending, composites with mixes between layers, and composites with mixes within a single layer for technological vehicles. Utilizing Carbon, Aramid, and Glass in NH and IN composites Combinations like Aramid-Carbon, Carbon-Glass, and Glass-Aramid intraply hybrid composites, various quantities of layers and the angles at which fibres are positioned are taken into account for optimal vibration characteristics. Experimental and numerical analyses, including Taguchi design, are conducted to determine effective manufacturing configurations. The results highlight the influence The count of layers, the angles they're positioned, and the kind of fabric used affect how something vibrates and how quickly it loses energy, helping compare interplay mix also intraply hybrid composites.

Tamiloli N et al. [18], Mixtures that have metal as a main part offer advantages popular aerospace, automotive, and engineering Used widely due to their excellent strength-to-weight ratio, durability, and erosion fight. This study employs optimal cutting parameters using fuzzy logic and order preference to explore the end milling of alumina-molted metal matrix composite. Response surface methodology establishes a numerical model, revealing the speed of material feeding is a critical aspect influencing reply variable quantity in the machining process.

Keya KN et al. [19] studied materials made from jute fibres and unsaturated polyester (50% by weight). Jute materials were strong, with a pulling force resistance of 42 Mega Pascals and the ability to endure bending forces. They could stretch a bit before breaking and resisted impacts. On the other hand, materials made from E-glass mat and unsaturated polyester resin (50% by weight) had even better qualities, showing almost twice the strength compared to jute materials

Dasari S et al. [20], the research investigates the impact of rapid carbon fibres (RCF) as subordinate reinforcement in interlaced glass/epoxy hybrid composites, exploring concentrations of 0.1, 0.3, and 0.5 wet% SCF—composites with 0.1 wt.% SCF demonstrated notable improvements in tensile and flexural assets in 29.02% and 16.08%, separately. Moreover, the study evaluates the fracture resistance between layers, showing enhanced Mode 1 and Mode 2 properties with 0.1 wt.% RCF incorporation. Skimming electron microscopy was employed to examine the fractured exteriors and also understand the underlying micro-mechanisms contributing to the observed results.

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Khan T et al. [21], research investigates glass/carbon hybrid fibre reinforced polymer composites with plain and twill weaves using the VARTM technique. Microstructural analysis shows improved fibre-matrix adhesion in hybrid composites, enhancing dynamic mechanical and flexural properties. Hybrid composites exhibit an important growth in flexural strength (149%) also modulus (144%) related to clean glass fibre reinforced polymer (GFRP) composites, with higher thermal stability observed in GFRP because of a greater amount of fibre material.

Rani M et al. [22], reviews recycling methods for waste from wind turbine (WT) blade composites at the end of their life, focusing on carbon and glass fibres. Different recycling approaches (mechanical, thermal, chemical, and combined) are discussed, emphasizing the need for environmentally friendly processes to reclaim fibres. The study aims to identify optimal recycling processes for WT blade waste, considering the energy-intensive manufacturing of carbon and glass fibres and highlighting potential high-value structural applications for recovered fibres.

Karuppannan Gopalraj S et al. [23], present a novel Heat-based recycling method for reclaiming carbon and glass fibres from manufacturing-based Waste from Material made stronger with carbon fibres and material made stronger with glass fibres, achieving high recovery rates. Optimal conditions for recycling placed at 550 °C under normal atmospheric pressure. The recycled fibres, with 95–98% and 80–82% recovery rates for CFs and GFs, respectively, were utilized to manufacture new composites with improved Strength under tension, elasticity, and impact resistance compared to conventional composites. The recycling method illustrated in a closed-loop system in the study showcases the potential for effective and sustainable recycling Leftover materials from making things with strengthened carbon fibre and strengthened glass fibre.

Biswal T et al. [24], Composites, formed by combining different materials, exhibit unique properties beneficial for various applications. This review focuses on polymer composites, exploring classifications, synthesis methods, and their significance in biomedical fields. The bioactive properties of these composites make them promising for applications like bone implants, artificial organs, and wound dressings, showcasing their potential in advanced medical research.

MANUFACTURING PROCESS

There are various manufacturing processes used in composite materials. Here are some Various ways of making things from composite materials.

Manufacturing Steps involved in making composite materials

- Hand-applied wet layers
- First, the strands are arranged in the form.
- The strands can be woven, sewed, sewed, or reinforced textures.
- Then the gum is impregnated.
- The impregnation aids in driving the sap deeper into the texture.
- The overlays produced in this cycle are subsequently reinstated under typical atmospheric conditions.
- There are generally no restrictions on the materials that can be used. Mix of substances like epoxy, polyester, vinyl ester, phenolic, and any fibre material can be employed.

Autoclave Curing

Autoclave curing is a high-pressure and high-temperature process used in composite material manufacturing, promoting the polymerization and curing of resins, resulting in enhanced material properties and reduced void content as shown in Figure.1 Autoclave Curing. This method is commonly employed for aerospace and high-performance applications.

Autoclave curing is a vital process in the manufacturing of composite materials, particularly those utilizing resins like epoxy. The autoclave curing cycle, often represented by an autoclave curve, involves a systematic temperature and pressure profile. Initially, the temperature is gradually ramped up to the desired curing temperature to avoid thermal stresses. Subsequently, during the soak phase, the temperature is maintained at a constant level, allowing the resin to fully cure and ensure proper bonding of composite layers. Following the curing phase, a controlled cooling period is implemented to prevent thermal shock, and depressurization occurs once the temperature is deemed safe. The autoclave curing process is crucial for achieving the desired mechanical and thermal properties in composite materials, with specific parameters tailored to the material composition and performance requirements. Adhering to recommended curing guidelines is essential for producing composite products with optimal strength, durability, and overall quality.

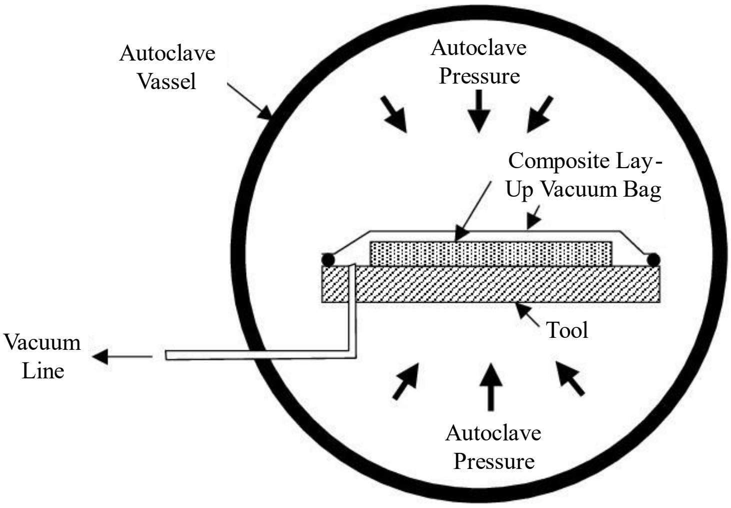

Figure 1. Autoclave Curing.

Filament winding Pultrusion

Filament winding is an engineering process where continuous fibres, typically fibreglass or carbon, are wound onto a rotating mandrel in a specific pattern. This method is commonly used for cylindrical structures, providing strength and durability. Pultrusion, on the other hand, involves pulling long fibres through a bath of liquid resin subsequently through a heated die to create a composite profile with a consistent cross-section. Both processes are widely used in composite material manufacturing for applications such as pipes, tanks, and structural components in Figure 2 Filament winding pultrusion.

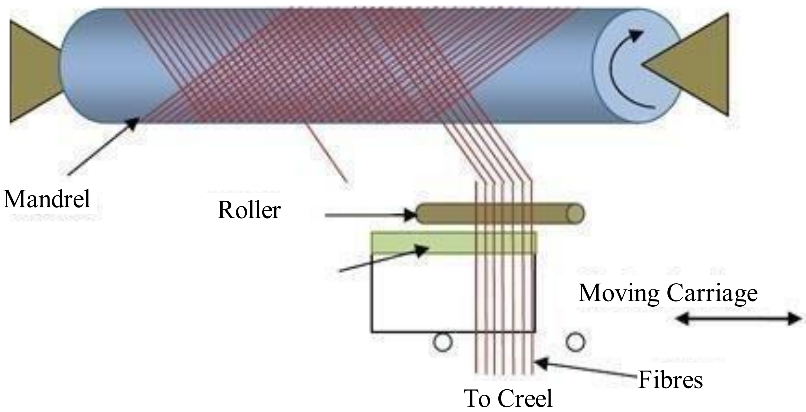

Figure 2. Filament winding pultrusion.

Resin preparation

Resin preparation involves mixing liquid resin, often epoxy or polyester, with a curing agent to create a homogeneous mixture like as shown in Figure 3 Resin Preparation. The resulting resin blend is then

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ready for application in various manufacturing processes like molding or laminating in composite material production.

To prepare epoxy resin, measure the required ratio of resin to hardener according to the manufacturer's instructions. Thoroughly mix the components in a clean container, ensuring homogeneity. Optionally, degas the mixture to remove air bubbles, and apply the epoxy to the desired surface. Allow proper curing time based on the formulation, and consider post-curing for enhanced properties as recommended by the manufacturer.

Figure 3. Resin Preparation.

Specimen Setting

3-D weaving enhances cross-over strength, as illustrated in Figure 4 Woven rolled E-glass fibre.

Crimpless weaves employ auxiliary yarns stitched to bind aligned primary yarns in at least one unidirectional orientation. Typically, these elevated levels are predominantly associated with woven E-glass strands.

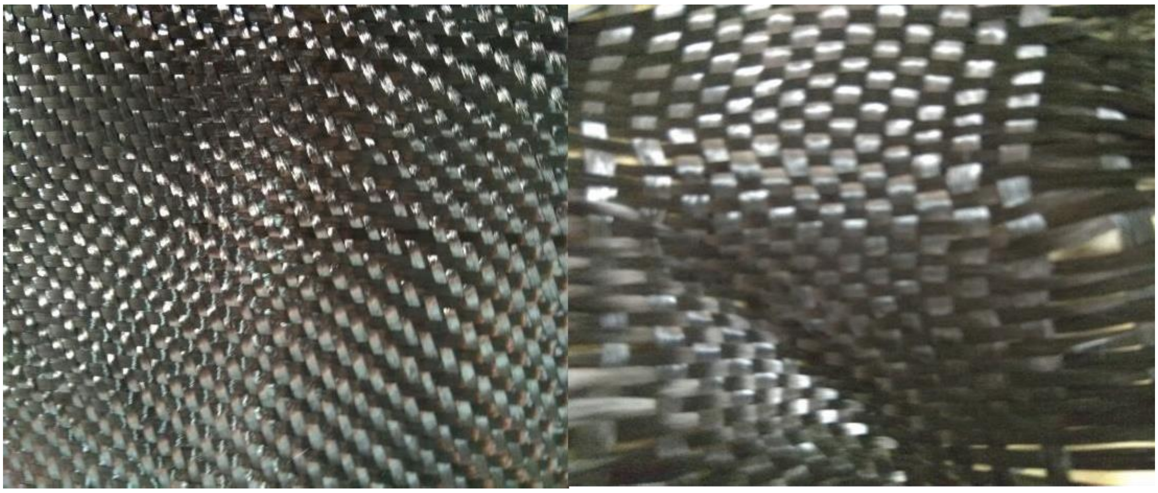

Figure 4. Woven rolled E-glass fibre.

Specimen setting Figure 5 refers to the preparation and arrangement of test specimens for various material testing processes, ensuring standardized conditions to evaluate mechanical, thermal, or other properties in a controlled and reproducible manner. Proper specimen setting is crucial for accurate and reliable material characterization in research and industry.

EXPERIMENTATION AND RESULTS

In engineering design, evaluating the structural integrity of materials is crucial, with tensile testing being a primary method. This test, performed at normal room temperature utilizing a universal testing machine, involves subjecting a standardized sample subjected to a slowly applied tensile force. The hydraulic mechanism applies force, and a pendulum dynamometer measures the load. Simultaneously, a lengthening scale with a 1 mm minimum count records the strain. The resulting stress and strain data are fundamental for determining material properties, ensuring quality, and guiding product design for safety considerations.

Figure 5. Specimen setting.

Testing Apparatus Description

The testing apparatus described involves a rotating cylinder mechanism designed to eliminate friction during operation, ensuring the pendulum's smooth return after a test sample fractures abruptly. To apply force, a hydrostatically lubricated ram is utilized, and the oil pressure in the pendulum dynamometer's main chamber is regulated from the control panel. The dynamometer's cylinder exerts a force proportional to the hydraulic pressure, transferred through a leverage system onto a pendulum. The pendulum's displacement activates a rack and pinion mechanism, facilitating the operation of a load-indicating pointer on a large dial. This dial represents the applied load, and an auxiliary pointer is provided to mark the maximum load reached during the test.

Additionally, the system incorporates a continuous roll-type load-elongation recorder for plotting load-extension diagrams. The horizontal movement of the rack generates the load ordinate on the chart, while the drum's rotation represents the extension. At the beginning of each test, a roll of chart paper is affixed to the drum, and the recording pen is inserted. The damping system is effectively engineered to absorb energy during sudden sample breakages, contributing to the reliability and safety of the testing process.

Procedure

Measure the initial distance (d) and assess the sample's length using a vernier caliper and a steel rule separately. Use a spot punch to mark the length with two tiny dots. Place the test Place the sample between the upper jaws of the testing machine and secure it facing upward using the hard wheels on the two crossheads (see Figure 6). Set the machine to zero on the elongation scale by adjusting the valves. Choose the right load range for the test piece's capacity by using the load selector handle on the control panel (see Figure 7). If the test sample is a composite material, make sure to choose the appropriate load range.

Place the pen in the pen holder of the load-length recording system. Before starting the test, set the load indicating pointer (black needle) and fake pointer (red pointer) on the control panel dial to zero. Close both the left and right control valves. To apply the load, press the pump "on" button, then slowly open the right control valve. Keep the left control valve closed. Increase the load on the sample gradually at equal intervals by opening the right valve, and note the corresponding length on the elongation scale in the recording system.

Figure 6. UTM testing machine.

Figure 7. Tensile test specimen in UTM machine.

Keep adding weight to the samples until they start to change shape. You'll notice this when the lengthening scale shows a high value of increase for the same amount of added weight. After this point, continue adding weight until the sample breaks. Right after it breaks, press the pump "off" switch Once the sample breaks, close the right valve, then slowly open the left valve to lower the weight. Remove the broken sample from the machine (refer to Figure 8). Measure the final length between the marked points and the width at the narrowest part of the sample using a ruler and callipers (refer to Figure 9). Calculate the crop point, maximum asset, extension amount, decrease in part rate, and modulus of elasticity.

After testing the specimen in the Universal Testing Machine (UTM) during a tensile test, the obtained data is typically used to generate a stress-strain curve. This curve Shows how the material reacts to applied axial load, including key features such as stiffness, point of deformation, maximum strength, and stretching ability at fracture. The results from the UTM provide valuable information about the material's mechanical properties and its suitability for specific applications in engineering and manufacturing.

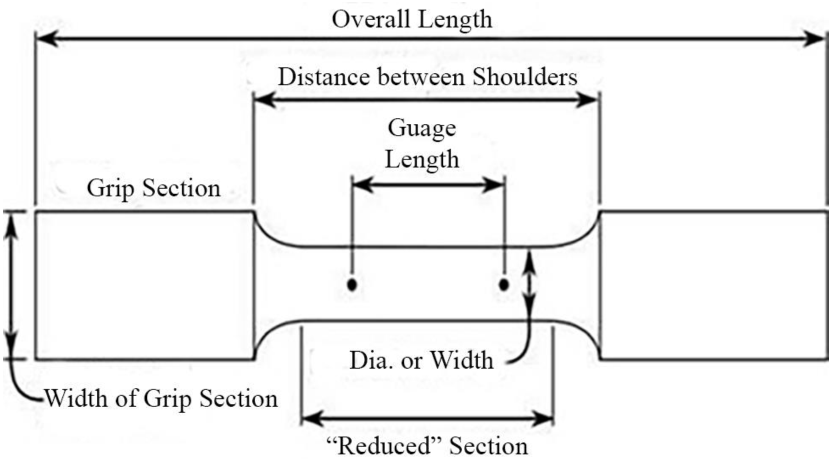

Figure 8. Standard Test Specimen.


Figure 9. Specimen after Tensile test.

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Impact Test

An impact test assesses the material's resistance to sudden dynamic loads Figure.10 Izod&Charpy testing machine. During this examination, a standard notched or unnotched specimen is subjected to a single forceful impact using a pendulum or falling weight. The energy absorbed by the specimen during fracture or deformation is measured. Impact tests, such as Charpy and Izod tests, are commonly employed to evaluate the toughness and notch sensitivity of materials, particularly metals and polymers. The results help in determining a material's resistance to sudden shock or impact loading Figure.11 Specimen after Charpy test bending Examination providing crucial insights into its performance in real-world applications.

Fabricate standardized impact specimens with controlled stress features. Secure them in the impact machine, ensuring precise alignment and calibration. Release the striker to impact the specimen, allowing energy absorption. Record the absorbed energy in joules during the test. Examine the specimen for deformation or fracture indications. Utilize the recorded data to evaluate the material's toughness and its resistance to sudden impact loads.

After the impact test procedure, the observed material behavior is evaluated based on the specimen's response to the applied force. Characteristics such as deformation, fracture patterns, and the amount of absorbed energy are analyzed. This assessment provides insights into the material's toughness, resilience, and ability to withstand sudden impact loads. The results contribute to understanding how the material will perform in real-world scenarios, aiding in design and safety considerations for applications in various industries.

Figure 10. Izod&Charpy testing machine.

Figure 11. Specimen after Charpy test Bending Examination.

CALCULATION

Tensile Test

The specimen's dimensions are:

- Length (L): 250 mm
- Breadth (B): 18 mm
- Thickness (D): 6 mm

The maximum load applied (W) is 42039.932N. Tensile strength (σ) is calculated using the formula σ = W/(B*D), resulting in 389.26N/mm².

Charpy and Impact Test

- The initial energy on the scale is 300 J.
- After testing, the residual energy on the scale is 28 J.
- The absorbed energy is calculated as 300–28, which equals 272 J.

Bending Test

For a steel leaf spring:

Weight (W): 10.776 kg

Without any load, the clearance between the ground and ends of the leaf spring (δ) is 169 mm.

- At 40 kg, the deflection is δ = 169–155, resulting in δ = 14 mm.
- At 60 kg, the deflection is δ = 169–149, resulting in δ = 20 mm.
- At 70 kg, the deflection is δ = 169–146, resulting in δ = 23 mm.

These tests provide valuable information about the material's strength, impact resistance, and flexibility.

A tensile test stress-strain graph Figure 12 tensile test illustrates the material's response to increasing load. The initial linear region reflects elastic deformation, followed by plastic deformation until reaching ultimate tensile strength. Beyond this point, necking occurs, leading to eventual material failure.

In a bending test, the stress-strain plot Figure 13 bending test illustrates the relationship between applied stress and resulting strain as a material undergoes bending deformation. The initial linear portion reflects elastic bending, while the plastic region indicates permanent deformation. Key parameters such as yield stress and modulus of elasticity are crucial in understanding the material's behavior under bending loads.

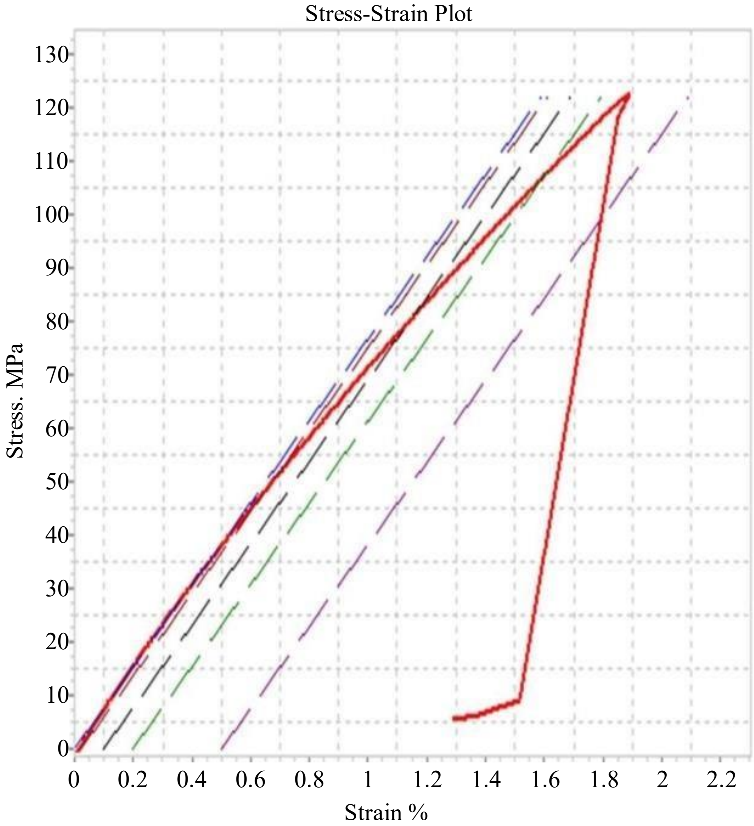

Figure 12. Tensile test.

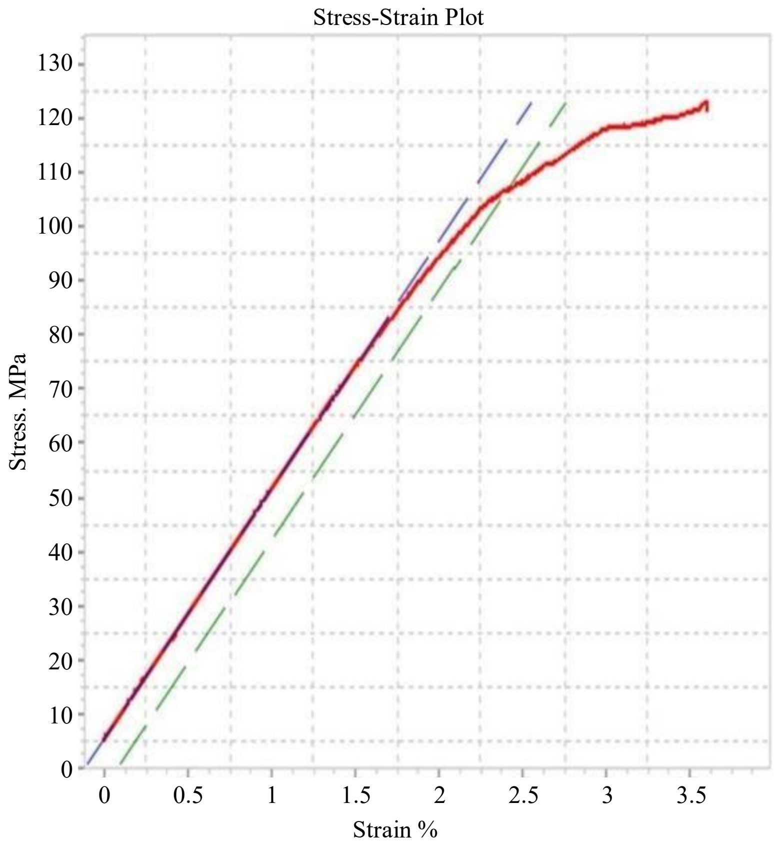

Figure 13. Bending test.

In both tensile and bending tests, stress-strain plots provide insights into a material's mechanical behavior. Tensile tests reveal the material's response to axial loading, showcasing elastic and plastic deformation, ultimate tensile strength, and fracture. In bending tests, the plot illustrates the material's behavior under flexural stress, identifying elastic and plastic regions, yield stress, and deformation patterns specific to bending. Both tests collectively offer a comprehensive understanding of material properties in different loading conditions

CONCLUSION

The composite product, consisting of resin and carbon fibre, underwent rigorous testing, including Tensile, Charpy, and Bending tests, following ASTM D638 and ASTM D790-03 standards.

In the Tensile test, the Composite leaf spring demonstrated exceptional strength, handling an Ultimate load of 42.039 KN, corresponding to an impressive Ultimate tensile strength of 35.038 KN/cm².

For the Charpy and Impact Test, conducted following ASTM D790-03 Standard, the Composite leaf spring exhibited remarkable resilience. The load at which the specimen fractured was measured at 9600 N. At this critical point, the cross-breaking strength was determined to be 28 N-m, further attesting near the robust mechanical properties of the compound material.

These results highlight superior performance and structural integrity of the Composite leaf spring, meeting and surpassing the standards set by ASTM D638 and ASTM D790-03. The product's capacity to withstand substantial loads and exhibit high tensile strength makes it a reliable and durable solution for its intended applications

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