OPTIMIZING AUTOMOTIVE PERFORMANCE: EVALUATING GLASS FIBER COMPOSITE WITH VARIED PLY ANGLES

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ABSTRACT

This study explores the efficiency of fiberglass composites in automotive applications through the analysis of different ply angles. Different composite samples were prepared using a specific ply configuration, subjected to different pressures (10, 20, and 30 Pascals) at room temperature The composites were made at the specified curing temperature for a period of time a have been explained. The specimens were characterized for tensile strength measurements, which provided complete information on mechanical properties. The aim of the study is to enhance the integrity and overall efficiency of the system by investigating the effect of different ply orientations and operating conditions which helps to obtain valuable insights for automotive parts depth lighter and more sustainable design and manufacturing Demonstrates how reductions can improve fuel efficiency.

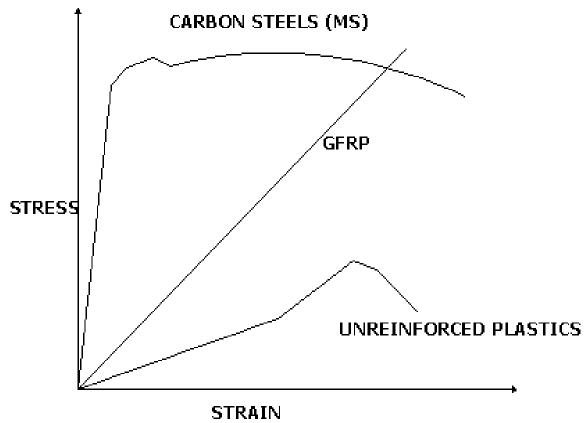
Keywords: *PLY ANGLES, DIFFERENT PRESSURE, MECHANICAL PROPERTIES, LIGHT WEIGHT*

1.INTRODUCTION:

Fibre reinforced plastics (FRPs) are being utilized as viable alternatives to metallic materials in structures where weight is a critical consideration, e.g., aerospace structures, high-speed boats, and trains. On the FRP side, glass fiber reinforced composites (GFRPs) provide good specific strength and stiffness in addition to their light weight and low cost and therefore find the use of GFRP composites in many automotive vehicles though improve fuel economy. However, when compared to metals which exhibit greater plastic deformation, GFRP composites often noticed with brittle behavior due to which their usage is limited in producing critical structural components. Further, the orientation of the fiber plies in the laminate decides the properties to the composites. Therefore, a thorough understanding on the fibre orientation and its effect is very much essential to generate the composite structures with enhanced mechanical properties and energy absorption capabilities. Composite samples were created using different ply angles (30°, 45°, 60°) and various pressures. The process involved assembling glass fabric and adding an epoxy matrix, forming the composite through a simple hand layup technique. Low fuel consumption, low weight and efficient use of natural materials are the main focus of automotive manufacturers in the current scenario. The above can be achieved by introducing good design ideas, quality products and product quality.

2.COMPOSITE MATERIALS

A composite is a product that is a combination of two or more components. Components are matched at the macroscopic level and do not overlap with each other. A material is called the reinforcing phase and the material in which it is embedded is called the matrix. Reinforcing phase material is usually continuous. The main difference between compounds and compounds is that, in compounds, the components are not mutually exclusive and the individual components retain those properties, where as in substances of a mixture, the substances do not dissolve in each other and from the properties of another distinct substance from the components.



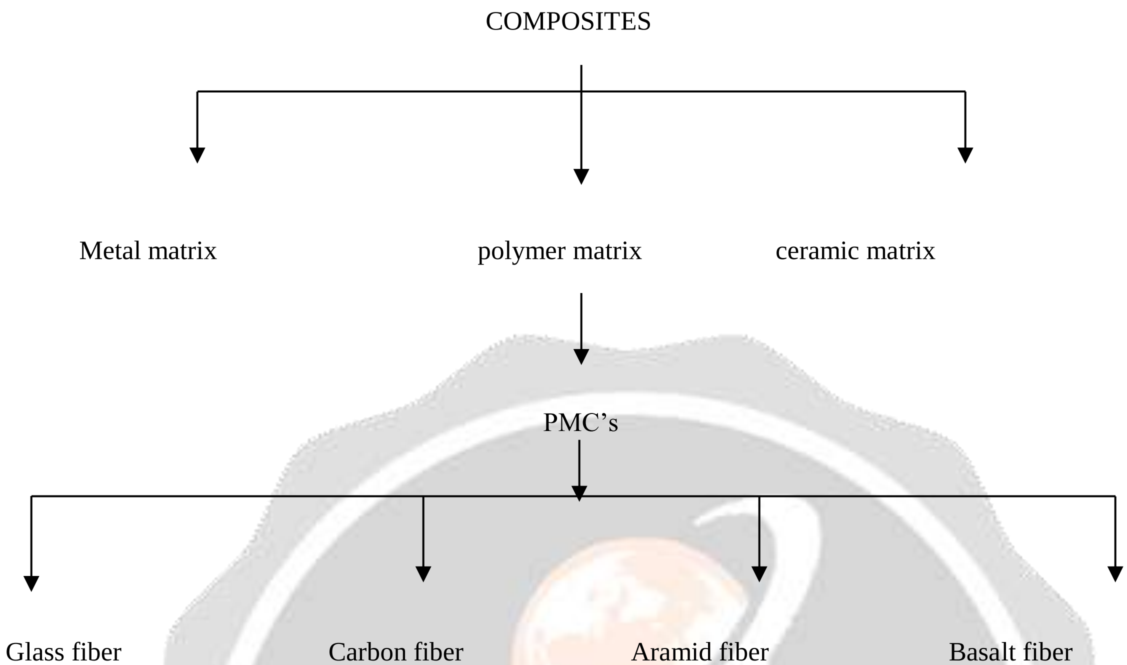
Stress Strain Curve for Different Materials

The stress and strain characteristics of fiber-reinforced plastics are different from most metals and plastics. Short term testing gives a linear stress/strain curve (as shown in figure) and it is found from the figure that there is no yield for GFRP. Both the fibers and the matrix retain those physical and chemical identities, but produce a combination of properties that cannot be achieved with either of the constituents acting alone. In general, fibers are the principle load carrying members, while the surrounding matrix keeps them in the desired location and orientation, acts as a load transfer medium between them and protects them from environmental damages due to elevated temperature and humidity.

Properties of composites are strongly influenced by the properties of their constituent materials, their type, their distribution and the interaction between them. Like conventional materials, composites are not homogeneous and isotropic. Composites are generally completely elastic up to failure exhibit no yield point or a region of plasticity.

2.1 CLASSFICATION OF COMPOSITE MATERIALS

The composite materials are classified as follows



2.2 ADVANTAGES OF COMPOSITE MATERIALS OVER OTHER MATERIALS

- Use of composite is more efficient.
- For example, in the more complex airline markets, they are constantly looking for ways to reduce the number of aircraft without reducing the stiffness and strength of composite aircraft This can be achieved by using composite materials to build steel on the replacement of conventional mixtures.
- Even if the cost of composite materials can be high, the benefits are outweighed by the reduction in parts in an assembly and the savings in fuel costs.
- Other advantages include improved
    - Specific strength
    - Stiffness
    - Fatigue and impact resistance
    - Thermal conductivity
    - Corrosion resistance
    - Low density

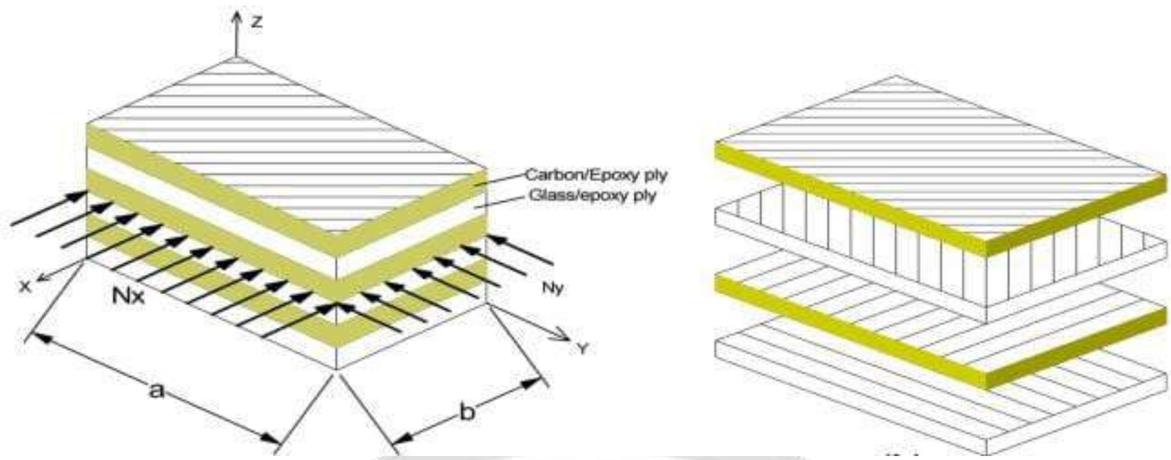
3. OUTER PANEL COMPOSITE:

Using glass fabric in automobile outer panels typically involves creating a composite material. The process involves impregnating the glass fabric with a resin, often epoxy or polyester, and then curing it to form a rigid structure. This composite provides strength, durability, and lightweight characteristics, making it a common choice for enhancing structural integrity in automobile components.

4. PLY ANGLE COMPOSITES:

The ply angle in composites refers to the orientation of individual layers (plies) within a composite material. These layers are often made of fibers embedded in a matrix. The orientation of fibers in each ply can significantly affect the mechanical properties of the composite.

Common ply angles include 0 degrees (unidirectional fibers aligned in the longitudinal direction), 90 degrees (transverse fibers perpendicular to the longitudinal direction), and angles in between (e.g., 45 degrees for a quasi-isotropic layup). Varying ply angles allows engineers to tailor the material properties for specific applications, optimizing factors like strength, stiffness, and impact resistance in different directions.



5. MATERIALS AND METHODOLOGY

5.1 GLASS FIBRE

Glass fiber, commonly known as fiberglass, is a lightweight and durable material made from thin strands of glass. Woven together, these strands form a flexible and strong material with excellent tensile strength, high stiffness, and resistance to heat and corrosion. Glass fiber finds extensive use in composite materials, such as fiberglass composites, for applications like automotive components, aerospace structures, boat hulls, and sporting goods.

Glass fibers contribute to construction materials, as seen in glass fiber-reinforced concrete (GFRC), enhancing the strength and durability of concrete structures. This versatility makes glass fiber a popular choice across multiple industries, contributing significantly to materials science and technological advancements**.**

5.2 EPOXY RESIN

Epoxy resin is a versatile synthetic polymer formed through the reaction of epoxide monomers with a curing agent. Once cured, it becomes a strong, durable, and chemically resistant material. Known for its excellent adhesive properties, epoxy resin is widely used for bonding various materials. It is also utilized in coatings, providing protection against chemicals, corrosion, and wear on surfaces.

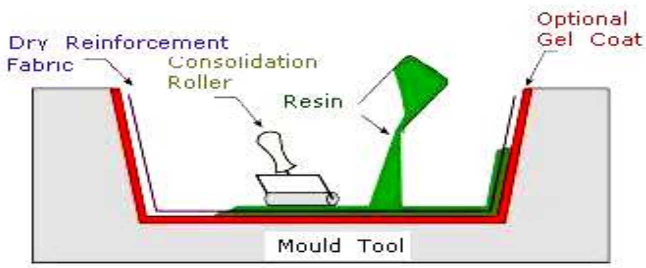
In the production of composite materials, epoxy resin, when combined with reinforcing materials like fiberglass or carbon fiber, creates strong and lightweight structures used in aerospace, automotive, and marine applications. Additionally, epoxy resin is employed in encapsulating and potting electronic components, ensuring their protection from environmental factors.

5.3 SAMPLE PREPARATION

Parameters required:

• Temperature - Room temp
• Time-5,10 and 15 min
• Pressure-10,20,30 kg/cm²

5.4 MANUFACTURING PROCESS OF COMPOSITE



In Hand lay-up, liquid resin is applied to the Mold and then glass fabric is applied. A roller is used to fill the fabric with resin. Another layer of resin and reinforcement is applied until the correct thickness is achieved. It is a very intuitive process that allows the user to customize the section by placing different fabrics and mat materials. Since the reinforcement is manually set, it is also known as a manual setting system. Although this process does not require much capital, it is labour intensive.

5.4.1 ADVANTAGES OF HAND LAY-UP PROCESS

This process requires minimal capital as equipment costs are relatively low compared to other methods.

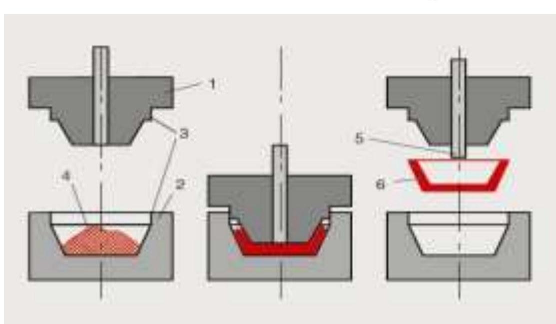
• The process is very simple and versatile. Any material can be selected with any fiber type.

• The cost of the prototyping part is relatively low as the part can be manufactured using simple molds. Moreover, the raw materials used in this process are liquid resins, mats and fabrics, materials, which are less expensive than manufactured goods

5.4.2 LIMITATIONS OF HAND LAY-UP PROCESS

- The process is labor incentive.
- The process is mostly is suitable for prototype as well as for making large structures.
- Styrene emission is major concern.
- The quality of the part produced is consistent form part to part. High fiber volume fraction cannot be produced with this method.

5.5 COMPRESSION MOULDING:



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Compression molding is a manufacturing process where raw material is placed into a mold, which is then closed, and pressure is applied to compress the material. Heat is added to soften or melt the material, causing it to take the shape of the mold. If the material is thermosetting, it undergoes a curing process. The molded part is then cooled within the closed mold before being removed once solidified. This process is commonly used for producing parts like automotive components and electrical insulators due to its advantages in production rates, tooling costs, and molding large parts.

6. TESTING METHODS

6.1 IMPACT TESTING

Impact testing of composite materials usually involves subjecting the material to controlled impacts to evaluate its strength and behavior under dynamic loading conditions Common methods include Charpy and Izod impact tests. These tests help evaluate the hardness, groove, and absorption properties of a material. The results are important for understanding the performance of composites in situations where sudden forces or shocks can occur.

6.2 FLEXURAL TESTING

A flexural test for composites, often known as a three-point or four-point bend test, assesses the material's bending strength and modulus of elasticity. It involves applying a load to the center of a specimen supported at its ends, creating a bending stress distribution. This test provides insights into the material's flexibility, stiffness, and ability to withstand bending forces. The results help in designing and evaluating composite materials for applications where bending loads are significant, such as beams or structural components.

6.3 TENSILE TESTING

A tensile test for composites is performed to assess the material's mechanical properties under axial loading. In this test, a specimen of the composite material is subjected to tension until it fractures. The test measures key parameters like ultimate tensile strength, yield strength, elongation at break, and modulus of elasticity. Tensile testing is crucial for understanding how composites respond to forces applied along their length and helps in characterizing their strength and ductility properties. It's a fundamental test in evaluating the performance of composite materials in applications where tensile loads are significant, such as in structural components.

7. CONCLUSION

The analysis of glass fiber composite using various ply angles for automobile applications provides a comprehensive overview of the research landscape in this domain. The investigation into the mechanical properties, structural performance, and manufacturing processes of these composites with different ply orientations has yielded valuable insights. The findings highlight the significance of ply angle selection in optimizing the mechanical behaviour and overall efficiency of glass fiber composites for automotive use. As the automotive industry increasingly embraces lightweight and high-performance materials, the knowledge synthesized in this review serves as a valuable resource for engineers and researchers aiming to enhance the design and performance of composite materials in automobile applications. The nuanced understanding of how ply angles influence the properties of glass fiber composites can contribute to the development of more efficient, durable, and lightweight components, ultimately advancing the broader goal of sustainable and innovative automotive technologies.

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