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A Review on Application of Fibre Reinforced Polymer Composite in Automotive Industry

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ABSTRACT: Fibre reinforced polymer (FRP) composite is the Composite material in which fibres are used to reinforce the polymer matrix for to improve its mechanical and chemical properties. Composites comprise strong load carrying material is known as reinforcement and weaker materials is known as matrix. Reinforcement provides stiffness and strength which helps to support structural load. Material plays an important role in the automotive parts. Fibre reinforced polymer (FRP) composite material are the best alternatives to the conventional materials like steel or aluminium used in the automotive industry at the point of view weight and cost. The properties of the Fibre Reinforced Polymer composite include greater design flexibility, high specific strength, high specific stiffness, non-corrosive nature, strong and lightweight.Glass fibre is the most widely used FRP material, because of its low cost and easy availability on the market.The other typical area of application of Fibre reinforced polymer composite includes aircraft industry, chemical industry, wind power plants, sporting goods, boats, ships etc. This paper attempts to review applications of Fibre Reinforced Polymer composite in automotive industry and opportunities of FRP composite towards industrial environment.

KEYWORDS: FRP, GFRP, Composite material, Polymer, Automotive application

I. INTRODUCTION

In recent years, the use of fibre reinforced polymer (FRP) composite materials has been rapidly growing across numerous industries, for example the aerospace, automobile, marine, and construction industries. Currently, a large proportion of industrial goods and mechanical parts are made from FRP composite materials as opposed to aluminium or steel.[3] A fibre reinforced polymer (FRP) is a composite material consisting of a polymer matrix imbedded with high-strength fibres, such as glass, aramid and carbon.[11] The properties of the FRP include greater design flexibility, non-corrosive, strong and lightweight. The FRP is stronger than steel or aluminum. The finished FRP can be curved, corrugated or ribbed. The easy design flexibility and mechanical properties makes the composite a promise for the future.[13] FRP composite manufacturing can be an energy-intensive process with high heat and pressure needed to bond the composite material together.[15] The composites technology has enabled the production of outstanding FRCs with respects to better damage tolerance, impact resistance, toughness, sustainability, renewability, strength, electromagnetic transparency, biodegradability, environmental superiority, cost and ease of productions, part count reduction, stiffness, design flexibility, low weight, mechanical damping, strength properties as well as chemical, thermal, high corrosion and wear resistance when compared with the conventional metallic engineering materials.[6] Automotive application of composites include bumper systems, instrument panels, leaf springs, drive shafts, fuel tanks, cross wheel beam, intake manifold.[13,12] The benefits of composite materials have their great stiffness and strength. There are in many cases, the reinforcement is stronger, tougher, harder and stiffer than the matrix. It finds application in automotive, aerospace, electronic equipment, sport goods, furniture, medical equipment & packaging Industry.[9]

1.1 GFRP (Glass Fibre Reinforced Polymer)

Glass fibre is the most widely used FRP material, because of its low cost and long-established availability on the market.[3] The glass fiber reinforced polyester (FRP) is a composite consisting of a plastic resin matrix, glass fiber

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reinforcement and other additives. The matrix itself alone does not provide any strength, but it serves as the bond for the reinforcing glass fibers.[13] The Glass fibre (GF) reinforcement and polypropylene (PP) matrix system is a commonly employed material combination, due to its high availability as well as low procurement costs.[4] The glass fiber reinforced composites are composite material system consisting of plastic resin matrix, glass fiber reinforcement and other additives. The glass reinforced composites are strong, lightweight and can be shaped as curved, corrugated, ribbed etc. The glass fiber composites are stronger than steel and aluminum.[13] A new polymer composite suspension spring promises to bring numerous benefits tothe automotive industry, benefits that drivers should ultimately be able to appreciateas well. Audi and Sogefi, an Italian automotive parts manufacturer, collaborated onthe development of a glass fiber-reinforced polymer spring, designed to replace steelsprings used as part of a car's suspension.[12]

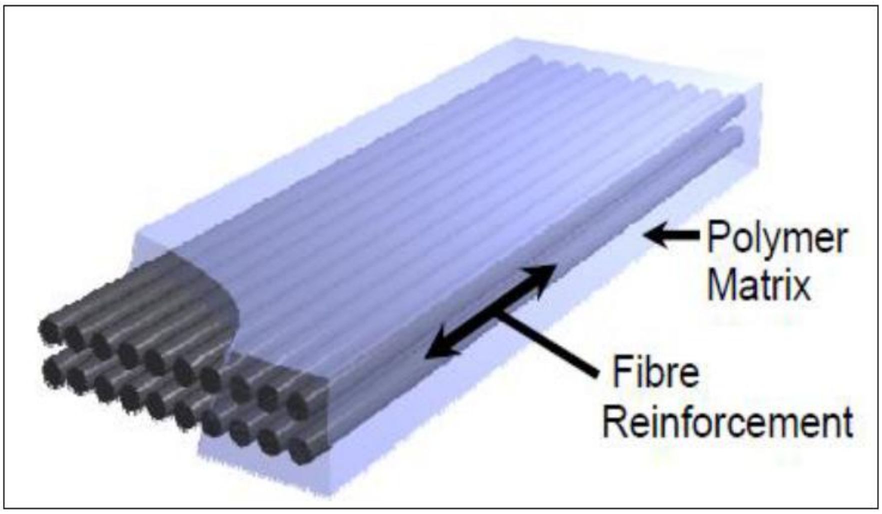

Figure:1Schematic of reinforcement and matrix forming a FRP composite

II. LITERATURE REVIEW

Arvindkumar K et al. (2014), Investigated Optimisation of Intake Manifold Design Using Fibre Reinforced Plastic. In this paper the design and manufacture of an intake system for a 600cc YAMAHA ZF engine Investigated. Intake system has a major effect on a vehicle's engine performance, noise and pollutants. Differences in engine outputs and applications require different designs of intake-air manifolds in order to achieve the best volumetric efficiency and thus the best engine performance. The result showed by using Fibre Reinforced Polymer there is reduction in weight, improved charge distribution, and increased torque through a wide RPM range when compared to its traditionally-manufactured aluminum counterpart.[1]

Chandramohan, D. et al. (2013) studied Natural Fiber Reinforced Polymer Composites For Automobile Accessories. Inthis research, natural fibers like Sisal (Agave sisalana), Banana (Musa sepientum) and Roselle (Hibiscussabdariffa), Sisal and banana (hybrid), Roselle and banana (hybrid) and Roselle and sisal (hybrid) arefabricated with bio epoxy resin using molding method. The applications of these materials require asustainable approach to creating green products. In this work, tensile and hardness of Sisal andbanana (hybrid), Roselle and banana (hybrid and Roselle and sisal (hybrid) composite at dry and wetconditions were studied. Hardness test were conducted using Brinell hardness testing machine. In this workmicro structure of the specimens are scanned by the Scanning Electron Microscope. The study includes the process to make the composite and also the variety of products in automobile accessories.[2]

Marianne Inman et al. (2017) investigated A mechanical and environmental assessment and comparison ofbasalt fibre reinforced polymer (BFRP) rebar and steel rebar in concrete beams. This paper compares holistically the mechanical and environmental performance of basalt fibre reinforced polymer (BFRP) rebar against conventional steel rebar in concrete beams. This assessment involves material testing and life cycle assessment (LCA). The results showed that BFRP tendons in reinforced concrete beams are stronger and lighter than steel with a better environmental profile and fewer embodied emissions, as fewer material and energy resources are required during production.[3]

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S.Suresh et al. (2014) investigated Experimental determination of the mechanical behavior of glassfiber reinforced polypropylene composites. In this study the influence of the forming pressure and coupler concentration on the mechanical behavior of glass fiber reinforced polypropylene composite laminates were investigated. The experimental results showed that the increase in forming pressure and coupler concentration initially increases both the mechanical properties, and then decreases the properties of the composite laminates. Compared to the coupler concentration, the forming pressure greatly improves both the tensile and flexural properties. Using the Scanning Electron Microscope (SEM), a morphological analysis was carried out to observe the bonding between the matrix and reinforcement.[4]
B.V.Kavad et al. (2014) review on effects of Drilling on Glass FiberReinforced Plastic. This paper attempts toreview the influence of machining parameter on the delamination damage of GFRP during drilling. In conventional machiningfeed rate, tool material and cutting speed are the most influential factor on the delamination hence machining at higher speed,harder tool material and lower feed rate have lesser delamination of the GFRP. Vibration assisted drilling and Ultrasonic assisteddrilling have lesser thrust and hence lesser delamination compared to conventional drilling, which indicates that both vibrationassisted drilling and Ultrasonic assisted drilling are more appropriate for drilling of GFRP.[5]
SikiruOluwarotimi Ismail et al. (2016) focused on Comprehensive study on machinability of sustainable and conventionalfibre reinforced polymer composites. This paper presents a comprehensive investigation on the machinability effects of drilling parameters (feed rate, cutting speed and thrust force), drill diameters and chips formation mainly on delamination and surface roughness of hemp fibre reinforced polymer and carbon fibre reinforced polymer composite laminates, using high speed steel (HSS) drills under dry machining condition. The results obtained depict that an increase in feed rate and thrust force caused an increase in delamination and surface roughness of both samples, different from cutting speed. Also, increased drill diameter and types of chips formation caused an increase in both delamination and surface roughness of both samples, as the material removal rate (MRR) increased.[6]
Thermo-mecha et al. (2016) investigated Effect of test temperature on fatigue crack propagation in injection molded plate of short-fiber reinforced plastics. The crack propagation behavior was studied at 298K (RT), 343K, 373K, and 403K with center-notched specimens which were cut from an injection-molded plates of short carbon-fiber reinforced PPS at two fiber angles relative to the loading direction, *i.e.* $\theta = 0°$ (MD) and 90° (TD). Macroscopic crack propagation path was nearly perpendicular to the loading axis for both MD and TD. Microscopically, cracks in MD were blocked by fibers, circumvented fibers, and rarely broke fibers, showed zigzag path. According to SEM observation of fatique fracture surfaces, many fibers were pulled out from the matrix on fatigue fracture surface of the skin layer of MD, and parallel fibers were observed on the fracture surface of TD.[7]
Tushar Sonar et al. reviews on Natural Fiber Reinforced Polymer Composite Material. This paper represents Natural fiber reinforcements have resulted in improved impact toughness and fatigue strength. Many efforts have been made by researchers towards improving mechanical properties, directed at improving the interface between fiber and polymer. This review aims at explaining about the research and development in the improvement in properties of natural fibre reinforced polymer composites along with its application.[8]
Gourav Gupta et al. (2016) reviews on Application and Future of CompositeMaterials. This paper present the current scenario ofapplication composites in industries and go towards the approach of composite material in future direction with itsadvantages, disadvantages and applications in industrial machinery. This paper also showed the Properties,Characteristics, Challenges, Opportunities and Future demand of Composite material towards industrial environment[9].
Ing. Eva Aková (2013) Focused on Developement Of Natural Fiber Reinforced Polymer Composites. The article reviews the recent development of natural fiber reinforced polymer composites, including an experiment on composites reinforced with hop fibers. This paper also present the properties of fibre reinforcement polymer and also its applications in the automotive sector.[10]

III. CONCLUSION

In this work, attempt has been made to present a literature review on Application of Fibre reinforced polymer composite in various field of automotive sector. Automobile parts requires light weight component to improve the efficiency of the vehicle at this point of view Fibre reinforced polymer composite is the best alternative to the existing materials like steel or aluminium. The production cost of Fibre reinforced polymer composite is lower than other metal material this leads the better advantage of Fibre reinforced polymer composite over steel or aluminium.

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Future research work can be done on various parts ot automobile like bumper systems, instrument panels, leaf springs, drive shafts, fuel tanks, cross wheel beam, intake manifold.

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