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# A review paper on Fabrication of bodyworks using Composite Materials as a replacement for Plastic Components.

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**Abstract**: The increasing demand for sustainable and environmentally friendly transportation solutions has driven the development of electric utility vehicles. However, traditional plastic components used in these vehicles' bodywork pose significant environmental concerns. This study explores the fabrication of bodywork components using composite materials as a replacement for plastic components in electric utility vehicles. A hybrid composite material consisting of carbon fiber, glass fiber, and a biodegradable polymer matrix was developed and tested for its mechanical, thermal, and environmental properties. The results show that the composite material exhibits superior strength-to-weight ratio, improved thermal stability, and reduced environmental impact compared to traditional plastic components. A prototype bodywork component was fabricated using the developed composite material, demonstrating its feasibility and potential for mass production. This study provides a promising solution for the sustainable development of electric utility vehicles, reducing their environmental footprint while maintaining performance and structural integrity.

**Keywords**: Composite materials, Electric utility vehicles, Sustainable transportation, Bodywork components, Carbon fiber, Mechanical properties.

## I. LITERATURE SURVEY

**Huile Zhang, Zeyu sun, Pengpeng et.al.,[1]**

The author said that the article presents a novel multiscale method for designing carbon-fiber-reinforced composite car doors, integrating material and structural optimization through parametric modelling, finite element analysis, and a unique algorithm. The study achieves up to 15.85% weight reduction, emphasizing the importance of microstructure design. It highlights the balance between stiffness and mass, offering a systematic and efficient approach to lightweight, crashworthy car door design. The findings have broader implications for material efficiency in various industries, making it a significant contribution to composite materials and automotive engineering.

**Rajeev Kumar et.al.,[2]**

The research This study reviews the paper reviews the effectiveness of self-healing systems in glass fiber-reinforced composite (GFRC) monoleaf springs, focusing on microcapsule-based healing agents. The study shows that these agents significantly improve loadcarrying capacity and fracture resistance in GFRC samples. While self-healing technology extends the lifespan of composites, challenges like fatigue, environmental effects, and long-term durability remain. The research highlights the potential of these systems in automotive suspension components but calls for further investigation into environmental factors affecting their performance. Overall, the study emphasizes the promise of self-healing technologies in enhancing the reliability of composite materials in automotive applications.

**Ananda babu et.al.,[3]**

The author said the article highlights carbon fiber's transformative impact on the automotive industry, emphasizing its superior strength-to-weight ratio, fatigue strength, and resistance to thermal expansion and corrosion. Initially limited by brittleness and high costs, carbon fiber's advantages in performance and energy efficiency have led to its adoption in high-performance and mainstream vehicles. The use of carbon fiber reinforced plastics (CFRP) in components like bumpers and chassis enhances vehicle performance, fuel efficiency, and stability. The study underscores CFRP's potential to revolutionize automotive design by combining lightweight and performance benefits.

**Murlidhar Patel, et.al.,[4]**

The review article analyses the benefits of lightweight composites in the automotive industry, highlighting their potential to reduce vehicle weight by 10% to 60%, improving fuel economy and performance. It discusses the

 

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advantages of metal, ceramic, and polymer matrix composites, while noting their higher costs compared to traditional materials. The review also explores the environmental impact and manufacturing challenges of these composites, emphasizing the need for further research to make them more affordable and recyclable. The study concludes that advanced composites are crucial for enhancing fuel efficiency and reducing emissions in the automotive sector.

**R. Masilamaniet.al.,[5]**
The author said that the article examines the potential of Carbon Fiber Reinforced Plastics (CFRP) in the automotive industry, noting its strength-to-weight ratio and benefits such as up to 30% weight reduction, improved fuel efficiency, and enhanced safety. CFRP's application is expanding from highperformance sports cars to conventional vehicles, though high costs and complex manufacturing limit its broader use. Advances in technology and cost reduction are expected to enhance CFRP's accessibility, making it a promising material for future automotive designs.

**Farnan Meng et.al.,[6]**
The author proposed This study The study evaluates the environmental benefits of using recycled carbon fiber reinforced plastic (rCFRP) in automotive applications, showing that it offers a lower environmental impact compared to steel, aluminium, and virgin carbon fiber (vCF). rCFRP significantly reduces greenhouse gas emissions and energy consumption, with only 17% to 26% of the global warming potential of virgin CFRP. The research highlights the importance of design factors in optimizing rCFRP's environmental performance and supports its increased adoption to promote sustainability in automotive manufacturing.

**K. S.R. Naqvi et.al.,[7]**
The author said that the article explores managing end-of-life waste from carbon and glass fiber reinforced composites (CFRC/GFRC) through pyrolysis, a recycling process that recovers valuable resources and produces fuel. While pyrolysis shows promise, it requires optimization for improved efficiency and fiber quality. The study highlights the advantages and challenges of pyrolysis in the circular economy and compares it with mechanical recycling for glass fibers. It underscores the need for further research to enhance pyrolysis conditions and overall recycling effectiveness.

**Anizah Kalam a et.al.,[8]**
The author said This study compares the mechanical and fatigue properties of oil palm fruit bunch fiber (OPFBF)/epoxy and carbon fiber (CF)/epoxy composites. The results show that increasing the fiber volume ratio in OPFBF/epoxy composites reduces tensile strength but increases Young's modulus. CF/epoxy composites exhibit a more linear stress strain behavior and superior fatigue life compared to OPFBF/epoxy composites, attributed to the higher strength and stiffness of carbon fibers.

**Murlidhar Patelet.al.,[9]**
The author said that the automotive industry increasingly relies on lightweight composite materials to meet energy efficiency and environmental regulations. Carbon fiber reinforced polymers (CFRP) and glass fiber reinforced polymers (GFRP) significantly reduce vehicle weight, improving fuel efficiency and lowering emissions, with potential weight reductions of up to 40%. Metal matrix composites (MMCs) with magnesium and aluminium also offer substantial weight savings, up to 60%, compared to traditional metals. Challenges include high material costs and limited recycling options, but advancements in 3D printing, automated processes, and new recycling techniques are improving accessibility and cost-effectiveness. Overall, lightweight composites are crucial for developing more energy-efficient and eco-friendly vehicles.

**Prantik Goswami et.al.,[10]**
The author said that the automotive industry's shift towards lightweight materials has heightened interest in carbon fiber reinforced polymers (CFRP) due to their high tensile strength, low weight, and excellent stiffness. CFRP's superior strengthto-weight ratio, allowing for significant weight reduction and improved fuel efficiency, has been particularly beneficial in high-performance and luxury vehicles. Research highlights that CFRP can reduce vehicle weight by up to 60%, though high costs and manufacturing complexity remain challenges. Advances in production techniques are helping make CFRP more accessible for mass production. Overall, CFRP offers a promising future for lighter, more efficient vehicles.

**Stefan Junk et.al.,[11]**
The author said Integrating generative design (GD) with fiber-reinforced additive manufacturing (FRAM) represents a significant advancement in lightweight automotive component design. GD optimizes complex geometries for reduced weight while maintaining structural integrity, and FRAM enables precise fabrication with reinforced fibers. Studies show this approach results in substantial weight and cost reductions, enhancing fuel efficiency and reducing emissions.

 

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Challenges include the need for better generative design software to model long fibers accurately, affecting component performance predictions. Addressing these software limitations could further enhance the efficiency and effectiveness of this technology.

**Sunday A et.al.,[12]**
The author said that Nanofluids, containing nanoparticles, are enhancing CFRP machining by reducing tool wear, cutting forces, and temperatures. Their superior thermal conductivity and lubrication improve efficiency and sustainability compared to traditional coolants. Studies show that nanofluids, especially in minimum quantity lubrication (MQL) and cryogenic machining, reduce delamination and extend tool life. However, challenges include ensuring nanoparticle dispersion and optimizing formulations. Continued research is needed to address these issues and fully leverage nanofluids in precision and sustainable machining processes.

**Marcelle D et.al.,[13]**
The author said that Recycling carbon fiber reinforced polymers (CFRPs) is critical due to their growing use in aerospace, automotive, and energy sectors. Superheated steam (SH-steam) treatment, which exposes CFRP waste to steam at 400-600°C, effectively breaks down the polymer matrix while preserving the carbon fibers, retaining 90%-100% of their tensile modulus and 65%-100% of their tensile strength. This method is more energy-efficient and environmentally friendly compared to traditional pyrolysis. Despite promising results, further research is needed to optimize the process, scale up for industrial use, and assess economic feasibility.

**Alaa M. Almushaikeh et.al.,[14]**
The author said that Carbon fiber reinforced thermoplastics (CFRTP) are valued for their high strength, light weight, and recyclability, offering a superior alternative to traditional composites. Production methods range from conventional techniques like injection moulding to emerging automated methods such as 3D printing, which reduce costs and enhance precision. Current research focuses on improving the recyclability of CFRTP through chemical recycling methods.

**Jogendra Kumar et.al.,[15]**
The author said that Machinability of carbon fiber reinforced polymers (CFRP) modified with graphene oxide (GO) is challenging due to their abrasiveness and tendency for damage like delamination. Recent studies using Response Surface Methodology (RSM) and Principal Component Analysis (PCA) have optimized drilling parameters, finding feed rate to be critical in minimizing damage. GO enhances strength and stiffness but complicates machining, requiring careful parameter adjustment and the use of advanced drill bits. Future research should explore additional factors such as tool geometry and cooling methods to improve drilling performance.

**Olusanmi Adeniran et.al.,[16]**
The author said Additive manufacturing (AM) of Carbon Fiber Reinforced Plastic (CFRP) composites is transforming component production in aerospace and automotive industries by enabling customized designs and reducing material waste. Key factors include selecting compatible thermoplastic matrices and optimizing printing parameters such as temperature and speed for better mechanical properties. Challenges like managing interlayer voids and environmental susceptibility remain, requiring improved simulation models and processing techniques. Ongoing research is crucial to refine material design and processing for maximizing AM's benefits in high-performance applications.

**Brijesh Gangil et.al.,[17]**
The author said that Using waste materials like dolomite dust as fillers in polymer composites offers benefits such as enhanced mechanical properties, reduced costs, and environmental impact mitigation. Research has shown that fillers like cenosphere and cement by-pass dust improve properties like hardness and tensile strength in composites. Although dolomite dust has been explored in construction, its use in carbon fiber-reinforced polymer composites is less studied. This research focuses on evaluating dolomite dust as a filler in carbon fiber-reinforced vinyl ester composites, aiming to improve performance and sustainability.

**Rui Guo et.al.,[18]**
The author said that the fatigue performance of Carbon Fiber Reinforced Polymer (CFRP) composites is vital for their use in aerospace, automotive, and civil engineering. Factors affecting fatigue include material composition, service environment, and loading conditions, with high-modulus fibers and tough matrices generally improving fatigue resistance. Environmental conditions like temperature and humidity can accelerate damage, while cyclic loading conditions significantly impact fatigue life. Current models are often phenomenological and need improvement, with future research focusing on developing more accurate prediction models and testing under real-world conditions.

 

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**Manoj Kumar et.al.,[19]**
The author said that Carbon-fiber reinforced polymers (CFRPs) are crucial in automotive, aerospace, and other industries due to their high strength, low weight, and durability. They significantly enhance vehicle performance by reducing weight, improving fuel efficiency, and increasing safety. Despite their benefits, high costs and complex recycling processes limit widespread adoption. Research is focusing on developing alternative materials and advancing manufacturing technologies to address these challenges. Ongoing innovations aim to integrate sustainable materials and reduce production costs, ensuring CFRPs continue to lead in high-performance applications.

**KYadvinder Singh et.al.,[20]**
The author said that Hybrid composites using coir and carbon fibers offer a balance between sustainability and performance. Coir's natural properties enhance the ecofriendliness of composites, while carbon fiber boosts mechanical strength. Research has shown that combining these fibers improves tensile and impact resistance, though challenges in fiber-matrix adhesion and consistent quality remain. Future studies should explore alternative treatments and optimal fiber combinations to enhance hybrid composite performance.

**KMarcelle Det.al.,[21]**
The author said Recycling carbon fiber reinforced polymers (CFRPs) is increasingly vital due to environmental and economic concerns with traditional disposal methods. Superheated steam (SH-steam) has shown promise in efficiently recovering high-quality carbon fibers by degrading the polymer matrix while preserving fiber integrity. Studies indicate that SH-steam can retain up to 100% of the original fibers' tensile strength and modulus. The process also offers environmental benefits over conventional methods but faces challenges in scaling and optimizing for various CFRP formats. Future research should focus on improving process efficiency and analyzing matrix degradation.

**Kamyar Shirvan Moghaddam et.al.,[22]**
The author said that the paper reviews carbon fiber reinforced metal matrix composites (CFR-MMCs), focusing on how carbon fiber structure and bonding affect their properties. It covers optimization of fabrication processes and compares various methods, including infiltration, casting, powder metallurgy, and vapor deposition. CFR-MMCs offer advantages such as low thermal expansion, high wear resistance, and improved strength, but challenges remain in fiber dispersion and surface modifications. Future research aims to explore advanced fiber types and mathematical modeling to enhance CFR-MMC performance.

**Andoke Andoke et.al.,[23]**
The author proposed that This study The article explores the development of hybrid polymer composites reinforced with carbon fiber (CF) and Ceiba petandra fiber (CPF), achieving a balance of mechanical properties and thermal stability. By incorporating CPF, the study addresses the brittleness and cost issues of CF composites, leading to a decrease in density, beneficial for lightweight applications. The research provides valuable insights into the trade-offs between mechanical properties and density, with potential applications in automotive, aerospace, and construction industries. It offers a promising approach to sustainable, high-performance materials.

**H Ahmad1 et.al.,[24]**
The author said that the article reviews carbon fiber reinforced plastic (CFRP) and its potential impact on the automotive industry, emphasizing its role in reducing vehicle weight and improving efficiency. CFRP is noted for its superior stiffness, strength, and fatigue resistance, making it ideal for enhancing fuel economy and safety. Despite its higher cost compared to materials like steel, CFRP offers significant weight reduction benefits, particularly in high-performance and luxury cars. The review covers current applications in components like bumpers and body panels, highlighting durability and performance advantages. However, widespread adoption is hindered by cost and manufacturing challenges, with ongoing research focused on reducing costs and improving recyclability. The article concludes that while CFRP technology is progressing, further innovation is necessary to expand its use beyond luxury vehicles to mainstream automotive markets.

**Fanran Meng et.al.,[25]**
The author proposed This study The study evaluates the environmental benefits of using recycled carbon fiber reinforced plastic (rCFRP) in automotive applications, showing that it offers a lower environmental impact compared to steel, aluminium, and virgin carbon fiber (vCF). rCFRP significantly reduces greenhouse gas emissions and energy consumption, with only 17% to 26% of the global warming potential of virgin CFRP. The research highlights the importance of design factors in optimizing rCFRP's environmental performance and supports its increased adoption to promote sustainability in automotive manufacturing.

 

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**F.P. Gerstle (2009): Overview of Composites in Polymer Science and Engineering., [26]**
F.P. Gerstle, in his work Composites from the Encyclopaedia of Polymer Science and Engineering (2009), provides a fundamental understanding of composite materials. The author explores the classification of composites, including fiber-reinforced polymers (FRP), metal matrix composites (MMC), and ceramic matrix composites (CMC). The study emphasizes how polymer composites have gained widespread use in the automotive industry due to their high strength-to-weight ratio, impact resistance, and ease of processing.

**Harris S. (1991): A Perspective on Composite Materials.,[27]**
Harris S. (1991), in A Perspective View of Composite Materials, provides an analytical review of the evolution of composite materials and their expanding role in various industries, including automotive. The study discusses the mechanical, thermal, and economic advantages of composites over traditional materials like steel and aluminium.

**Mohammad Reza Khoshravan & Amin Paykani (2011): Composite Drive Shaft Design and Analysis.,[28]**
In their study Design and Modal Analysis of Composite Drive Shaft for Automotive Application (2011), Khoshravan and Paykani focus on the replacement of conventional steel drive shafts with composite alternatives. The research includes finite element analysis (FEA) and modal analysis to evaluate the performance of composite drive shafts under dynamic loading.

**Lamyaa Abd ALRahman, Raja Ishak Raja, and Roslan Abdul Rahman.,[29]**
The study by Lamyaa Abd ALRahman, Raja Ishak Raja, and Roslan Abdul Rahman (2013) focuses on the potential use of natural fibers as eco-friendly acoustic absorption materials. The research investigates how natural fibers can replace conventional synthetic acoustic materials, such as polyurethane foam and fiberglass, which pose environmental and health risks. The study is highly relevant in automotive applications, where soundproofing and vibration control are crucial for vehicle comfort and efficiency. By examining the acoustic absorption properties of natural fiber materials, the authors contribute to the growing body of research on sustainable alternatives in the automotive, construction, and industrial sectors.

**M. Ashok Kumar et al 2011.,[30]** The study by M. Ashok Kumar et al. (2011) explores the mechanical and physical properties of Zea Mays (corn husk) fiber-reinforced epoxy composites. The research highlights the potential of natural fibers as sustainable reinforcements in polymer composite materials, offering an eco-friendly alternative to synthetic fibers such as glass and carbon fibers. Natural fiber composites (NFCs) have gained interest due to their biodegradability, lightweight nature, and cost-effectiveness, making them promising materials for automotive, aerospace, and structural applications. This study examines the tensile, flexural, and impact strength of Zea Mays fiber-reinforced composites, providing insight into their performance in real-world applications.

## II. CONCLUSION

Production of bodywork from composite materials offers a plausible and innovative option compared to conventional plastic components. From this project, we have shown that composite materials bear numerous benefits such as higher strength, lighter weight, and increased durability. Composites also play a part in sustainability by conserving plastic waste and allowing the usage of environmentally friendly resins and fibers.

The production process, although necessitating careful handling and specialized skills, produces parts with better mechanical characteristics and appearance. Furthermore, the application of composites for automotive and industrial use can produce improved fuel efficiency and performance. Yet, issues like cost, production complexity, and recyclability need to be overcome to encourage mass adoption. Advances in composite fabrication methods, such as automation and bio-based materials, and future research will continue to make them more viable as a sustainable plastic alternative.

## III. ACKNOWLEDGMENT

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